Airspace Technology Demonstration 2 (ATD-2)

Latest IADS Capabilities

Shivanjli Sharma, Bob Staudenmeier, and Lindsay Stevens

March 14, 2018

Remote Demo Series – Schedule

- ~~ATD-2 101 (General Briefing and Demo) May 5th 11AM–1PM EST~~
- ~~ATD-2 101 (General Briefing and Demo) June 9th 11AM–1PM EST~~
- ~~ATD-2 201 (Surface/TBFM Scheduling) July 20th 10–11:30 AM EST~~
- ~~ATD-2 101 (General Briefing and Demo) Aug 3rd 10 - Noon EST~~
- ~~ATD-2 201 (Surface ON time predictions, Runway assignments) Aug 24th 10:30–Noon EST~~
- ~~ATD-2 301 (Fuser, SWIM Processing & Mediation, Matching) Sept 7th 10:30–Noon EST~~
- ~~ATD-2 201 (Tactical Surface Metering) Sept 21st 10:30–Noon EST~~
- ~~ATD-2 201 (Ramp Traffic Tools, Capabilities, Best Practices) Oct 12th 10:30–Noon EST~~
- ~~ATD-2 101 (General Briefing, Field "go-live" status update) Nov 9th 10:30–Noon EST~~
- ~~ATD-2 201 (Real-time Dashboard, Post Ops, Current Reports, Data Analysis) Dec 14th 10:30–Noon EST~~

- ATD-2 201 (Latest IADS Capabilities) March 14th 11am–Noon EST

- ATD-2 201 (Surface Metering - Initial Analysis, Impact, and Evolution) March 21st 11am–Noon EST

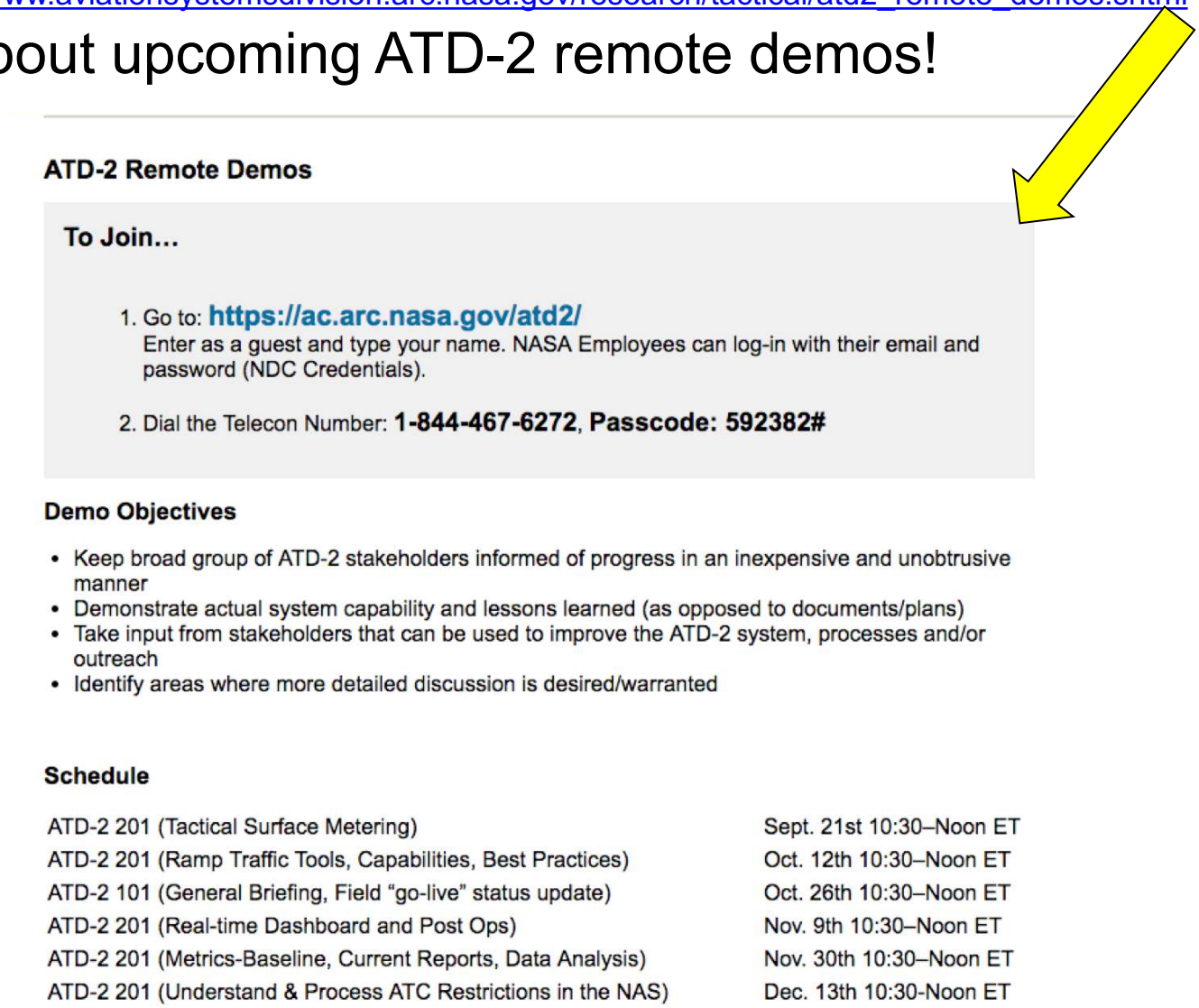
- What would like to see here? Send input to Al.Capps@nasa.gov

ATD-2 Remote Demo Objectives

- Keep broad group of ATD-2 stakeholders informed of progress in an inexpensive and unobtrusive manner
- Demonstrate actual system capability and lessons learned (as opposed to documents/plans)
- Take input from stakeholders that can be used to improve the ATD-2 system, processes and/or outreach
- Identify areas where more detailed discussion is desired/warranted

Upcoming Demos!

Go to https://www.aviationsystemsdivision.arc.nasa.gov/research/tactical/atd2_remote_demos.shtml to learn about upcoming ATD-2 remote demos!



ATD-2 Remote Demos

To Join…

1. Go to: **https://ac.arc.nasa.gov/atd2/**
   Enter as a guest and type your name. NASA Employees can log-in with their email and password (NDC Credentials).
2. Dial the Telecon Number: **1-844-467-6272, Passcode: 592382#**

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Schedule

ATD-2 201 (Tactical Surface Metering)	Sept. 21st 10:30–Noon ET
ATD-2 201 (Ramp Traffic Tools, Capabilities, Best Practices)	Oct. 12th 10:30–Noon ET
ATD-2 101 (General Briefing, Field "go-live" status update)	Oct. 26th 10:30–Noon ET
ATD-2 201 (Real-time Dashboard and Post Ops)	Nov. 9th 10:30–Noon ET
ATD-2 201 (Metrics-Baseline, Current Reports, Data Analysis)	Nov. 30th 10:30–Noon ET
ATD-2 201 (Understand & Process ATC Restrictions in the NAS)	Dec. 13th 10:30-Noon ET

AOSP R&D Partnership Workshop

Go to https://aviationsystemsdivision.arc.nasa.gov/aosp-partnership-workshop/registration.html to learn about the upcoming AOSP R&D Partnership Workshop!

NASA Airspace Operations and Safety Program Research & Development Partnership Workshop

Meet with NASA to discuss the future of the NAS: how to accommodate a diverse mix of airspace uses while maintaining highly efficient, safe, predictable, agile, and affordable airspace operation systems.

April 10-12, 2018

NASA Ames Conference Center
Building 152
NASA Ames Research Park, Moffett Field, CA

R&D Partnership Workshop

Notional Agenda

Tuesday, April 10			
8:30 – 8:50 am	Welcome and Introduction Workshop goals, structure, and format		Parimal Kopardekar, Senior Technologist for Air Transportation Systems
8:50 – 9:10 am	Aeronautics Research Mission Directorate (ARMD) Overview		Bob Pearce, Deputy Associate Administrator for Strategy
9:10 – 9:30 am	Airspace Operations and Safety Program (AOSP) Overview		Akbar Sultan, Deputy Director, Airspace Operations and Safety Program
9:30 – 10:00 am	Airspace Technology Demonstrations (ATD) Project Overview		Leighton Quon, Project Manager, ATD
10:00 – 10:30 am	UAS Traffic Management (UTM) Project Overview		Ron Johnson, Project Manager, UTM
10:30 – 11:00 am	**Break**		
11:00 – 11:30 am	ATM-X (Air Traffic Management - eXploration)		William Chan, Project Manager, ATM-X
11:30 am – 12:00 pm	System-Wide Safety (SWS) Project Overview		John Koelling, Project Manager, SWS
12:00 – 2:00 pm	**Lunch**		
2:00 – 3:15 pm	**Breakout Session 1 (refer to topic list for titles)**		
	Topic A (ATD)		Topic B (UTM)
3:15 – 3:45 pm	**Break**		
3:45 – 5:00 pm	**Breakout Session 2 (refer to topic list for titles)**		
	Topic C (ATD)		Topic D (SWS)
Wednesday, April 11			
8:30 – 9:45 am	**Breakout Session 3 (refer to topic list for titles)**		
	Topic E (UTM)		Topic F (SWS)
9:45 – 10:15 am	**Break**		
10:15 – 11:30 am	**Breakout Session 4 (refer to topic list for titles)**		
	Topic G (ATM-X)	Topic H (SWS)	Topic I (ATM-X)
11:30 am – 1:30 pm	**Lunch**		
1:30 – 2:45 pm	**Breakout Session 5 (refer to topic list for titles)**		
	Topic J (ATM-X)		Topic K (SWS)
2:45 – 3:15 pm	**Break**		
3:15 – 4:30 pm	Brief out/Panel discussion		
4:30 – 5:00 pm	Closing		Parimal Kopardekar
Thursday, April 12			
9:00 am – 4:00 pm	Demonstrations and Meetings		

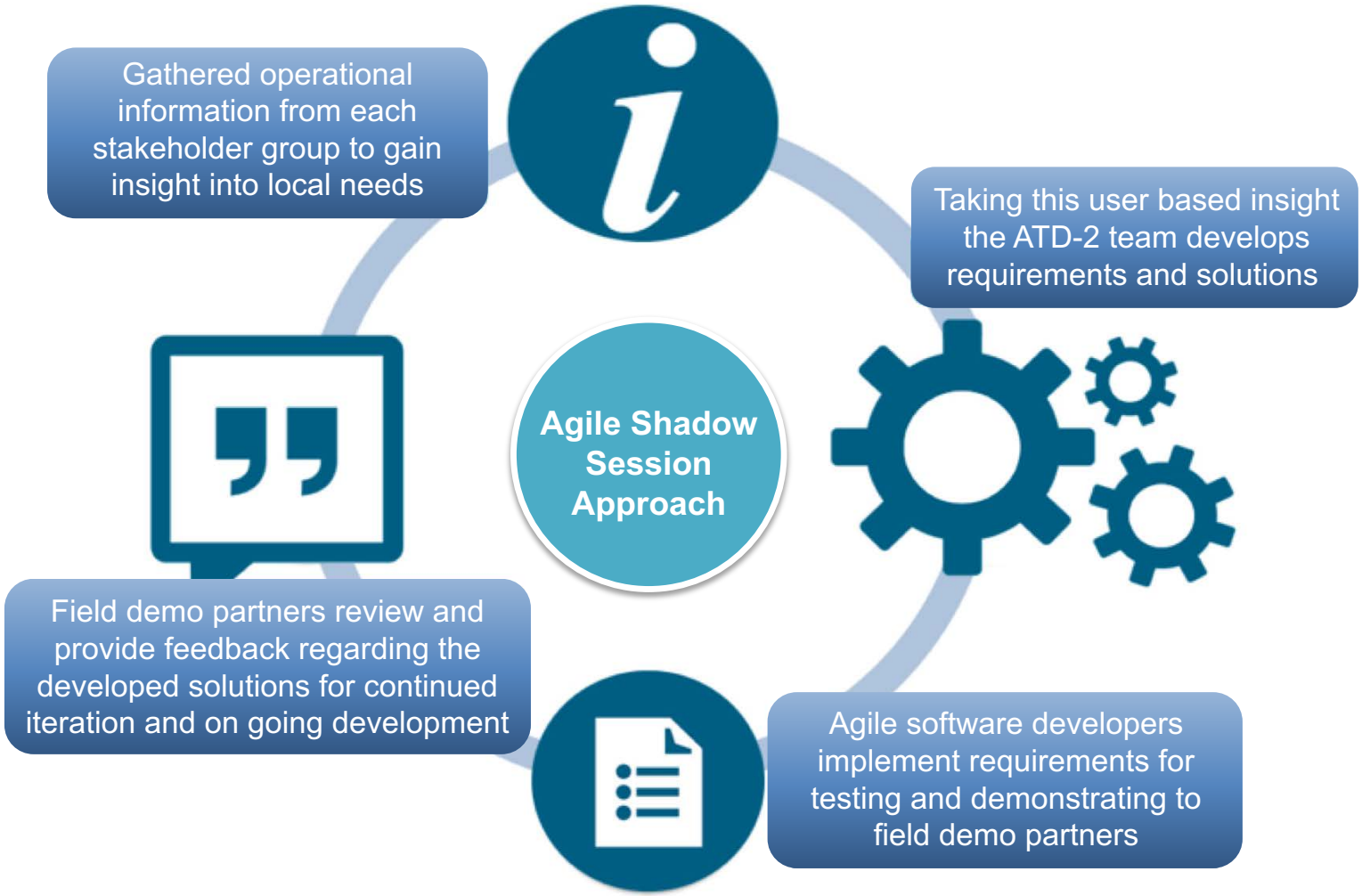
Demo Recordings

- The audio and video from this demo are being recorded

Agenda

- Agile Software Development Continuing Into Phase 1
- Baseline IADS System at Phase 1 Go Live
- Expanding Data Exchange and Integration
- Evolution of Overhead Stream Insertion and Surface Metering
- Expanding Real Time Tools
- Lessons Learned

Phase I Continued Shadow Sessions



Continued Shadow Sessions into Phase I

Sep 29, 2017

Phase 1 Go Live

Phase 1 System in Use in CLT ATCT and AAL Ramp

Oct 2017

Nov 2017

Feb 2018

April 5, 2018

FRZ2

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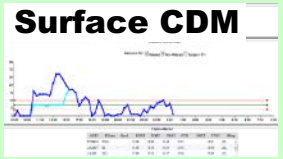
April 5, 2018 — **FRZ2**

Phase 2: Fused IADS Demonstration

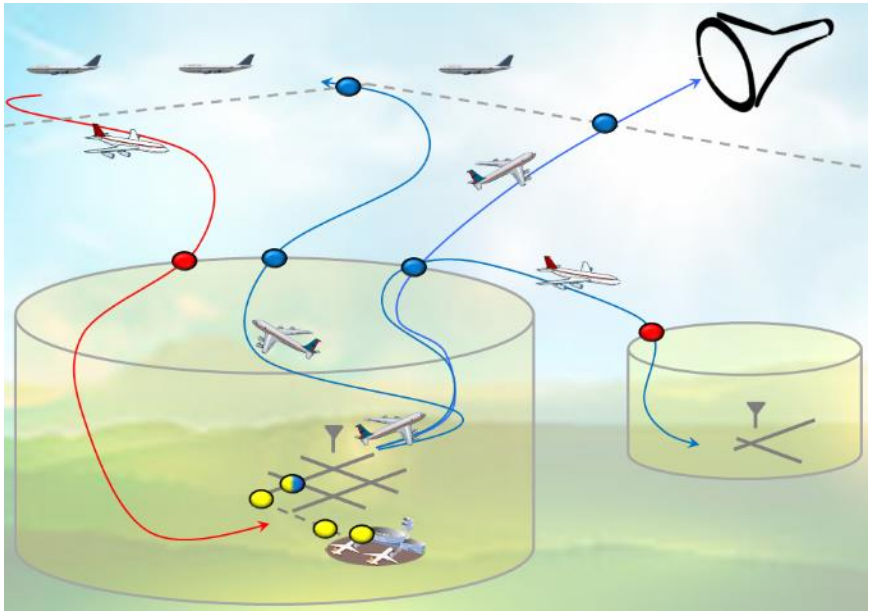
- Phase 1 capability plus:
- Include IADS info on EFD

- Phase 1 capability plus:
- Fused scheduler pushback advisories honor strategic TMATs



- Phase 1 capability plus:
- Prescriptive mode: strategic TMATs applied as constraints in fused scheduler

Surface Components



Phase 2 Demonstration Goals

- Evaluate the Fused IADS system capability
- Demonstrate benefits of strategic surface metering during periods of significant demand/capacity imbalance
- Enhance tactical surface metering to improve *non movement area* predictability and throughput
- Evaluate inclusion of IADS data on EFD
- Expand to demonstrate more scheduling scenarios for Washington and Atlanta Centers

- Phase 1 capability plus:
- Improvements as needed

- Phase 1 capability plus:
- Expand to ZTL TMU
- Integrate with arrival metering

- CLT TRACON TMU
- ATD-2 UI for TMI entry and situational awareness

Airspace Components

Interfaces to external systems via SWIM plus ATD-2 SWIM extensions

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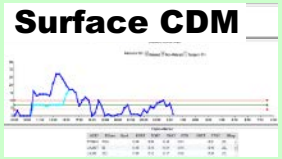

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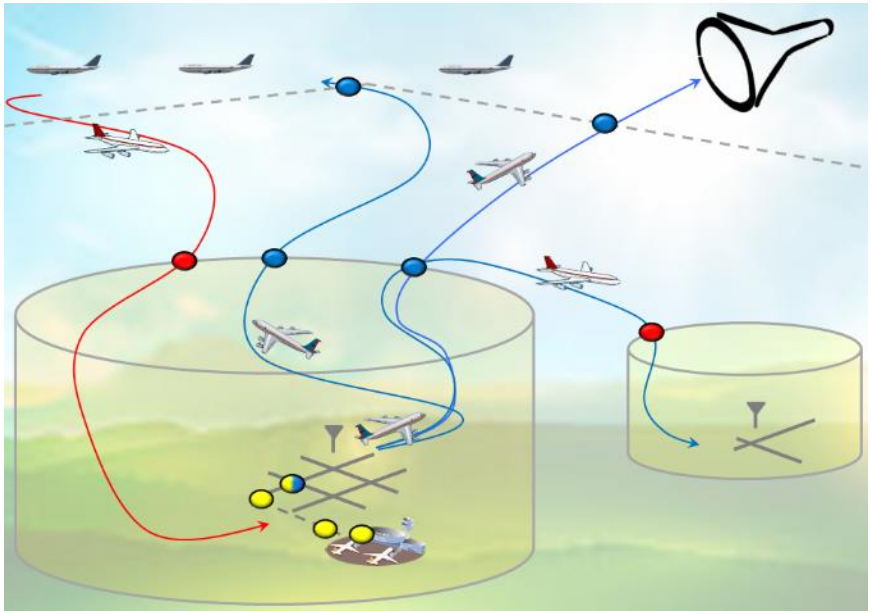

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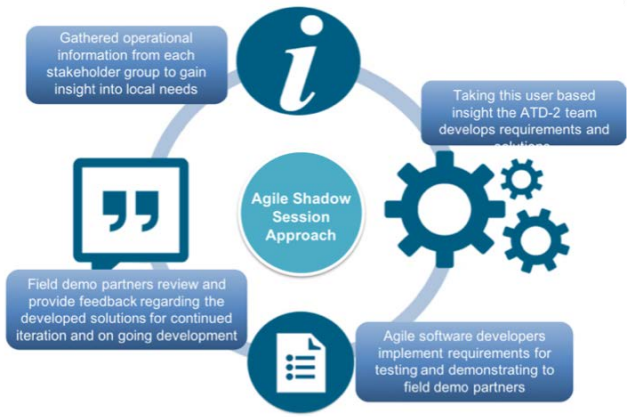
Interfaces to external systems via SWIM plus ATD-2 SWIM extensions

Software Updates Since Phase 1 Go Live



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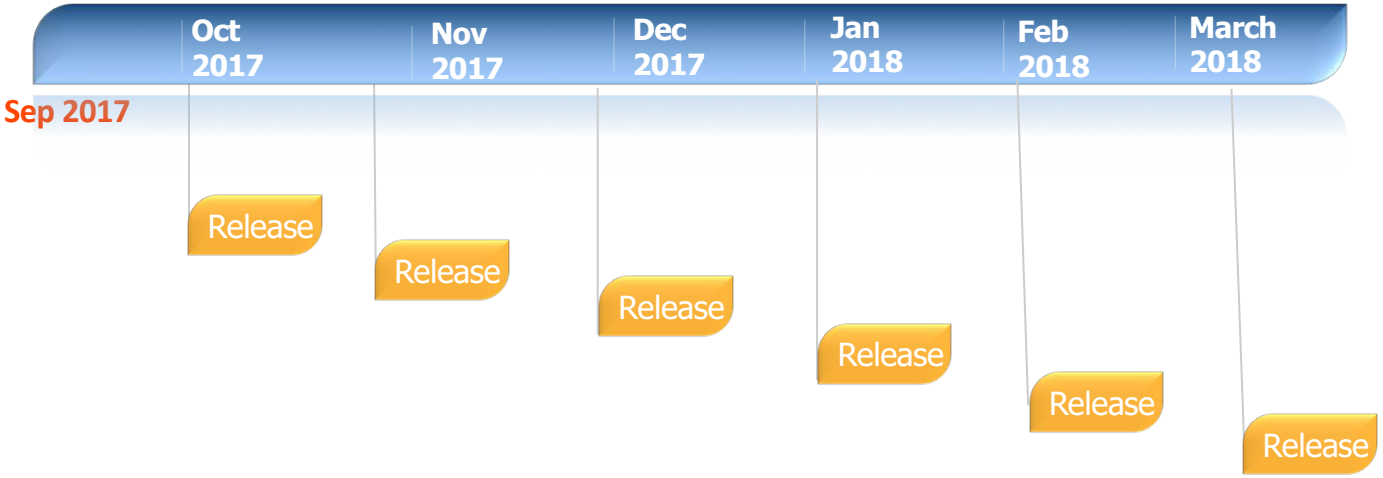
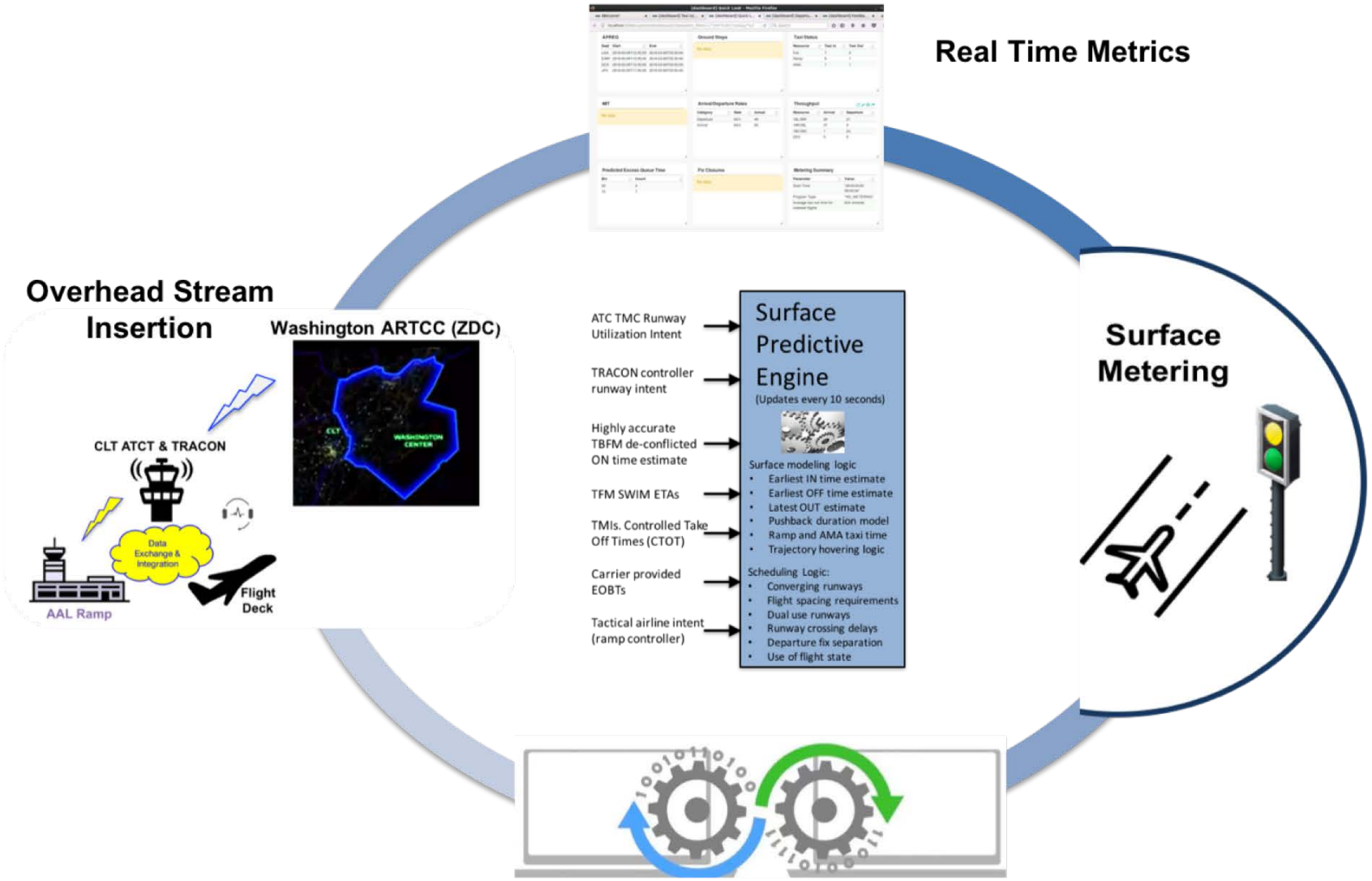
Phase 2: Fused IADS System Requirements

Drive software development and release schedule



IADS Phase 1 Capabilities



ATD2 System Running in the Field

STBO – Surface Trajectory Based Operations

RTC – Ramp Traffic Console

DASH – Data Analysis and System Health

What If System

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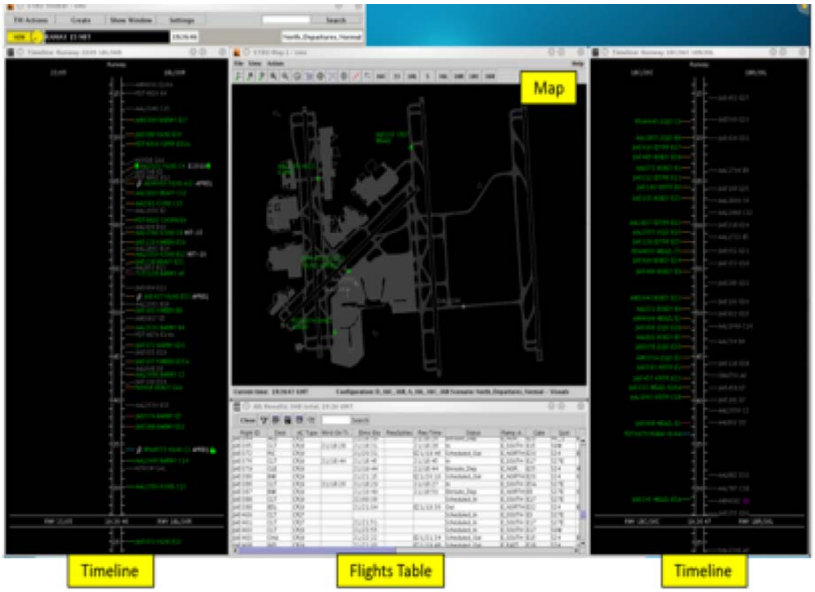

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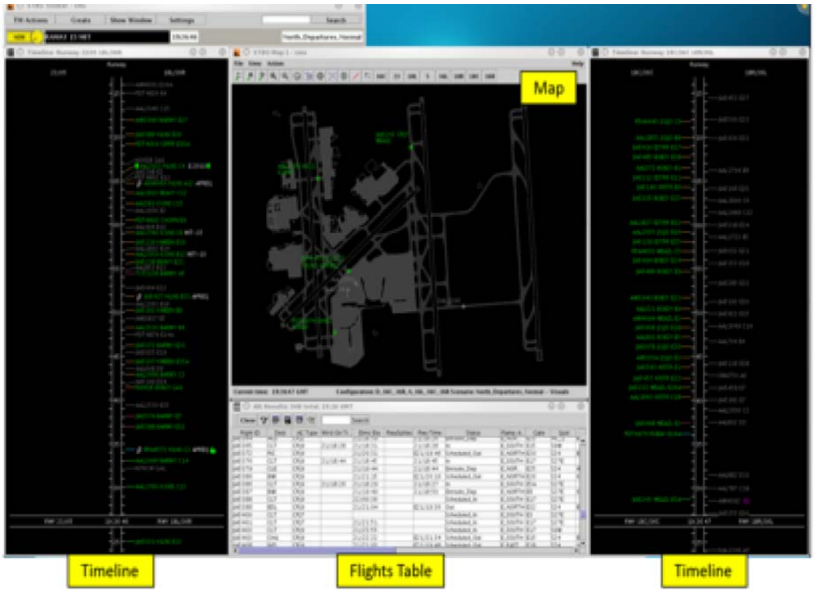

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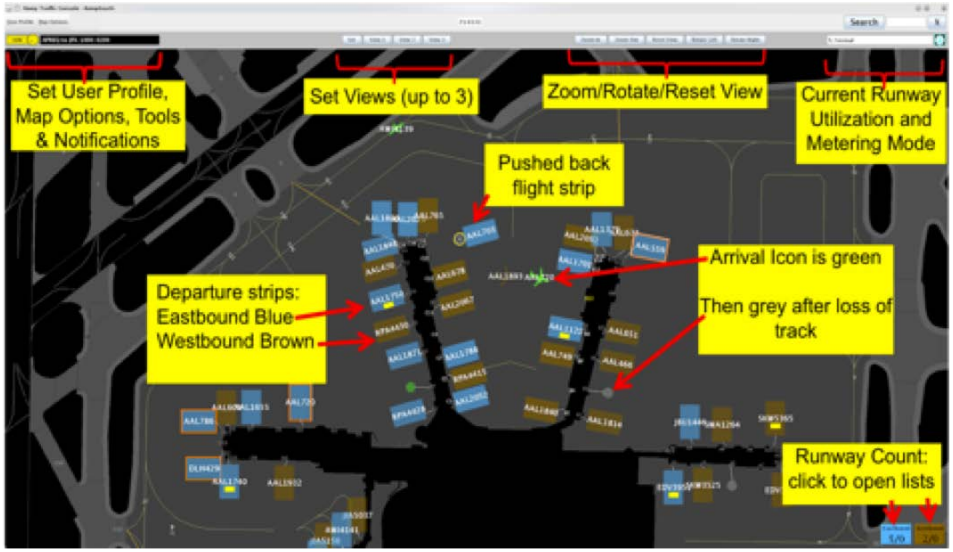

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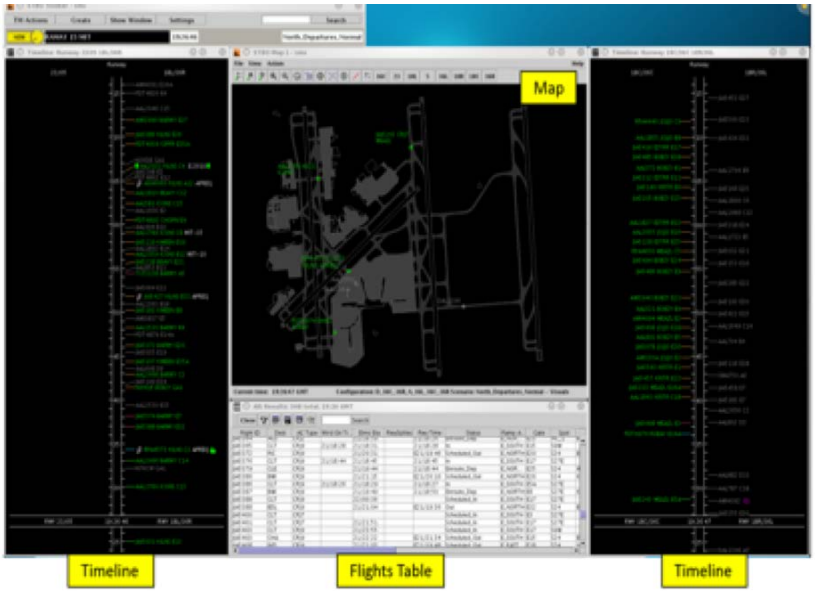

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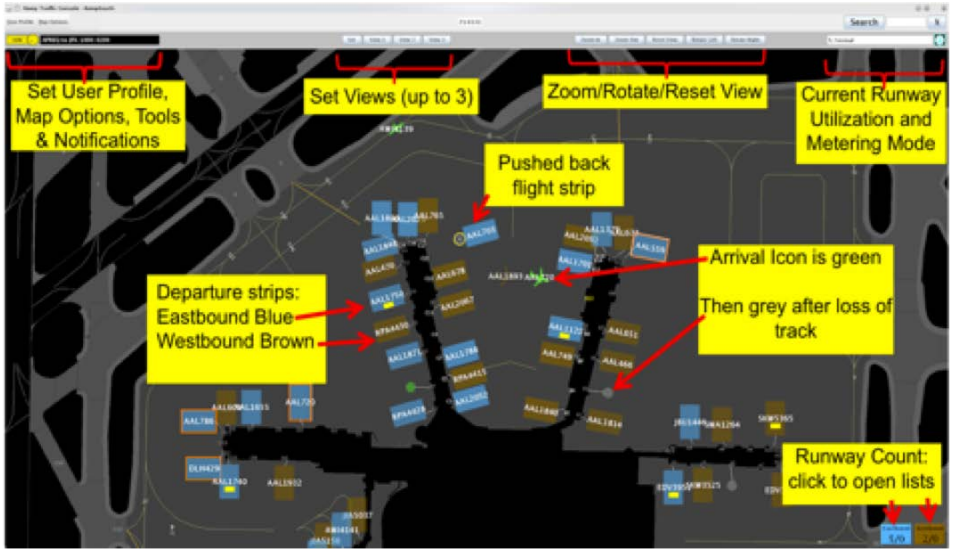

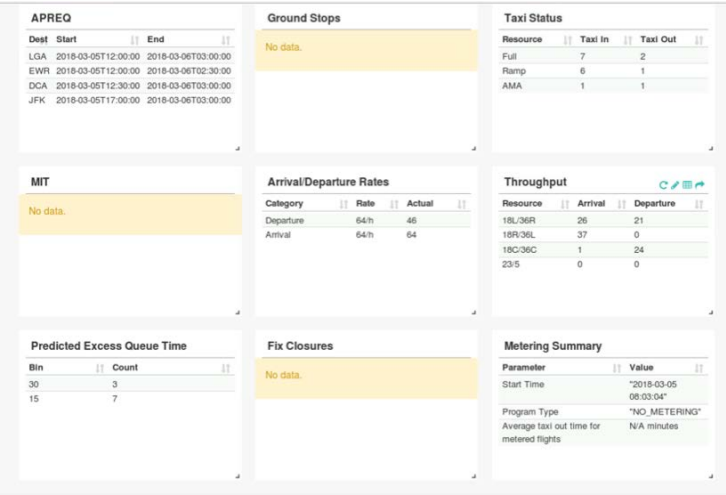

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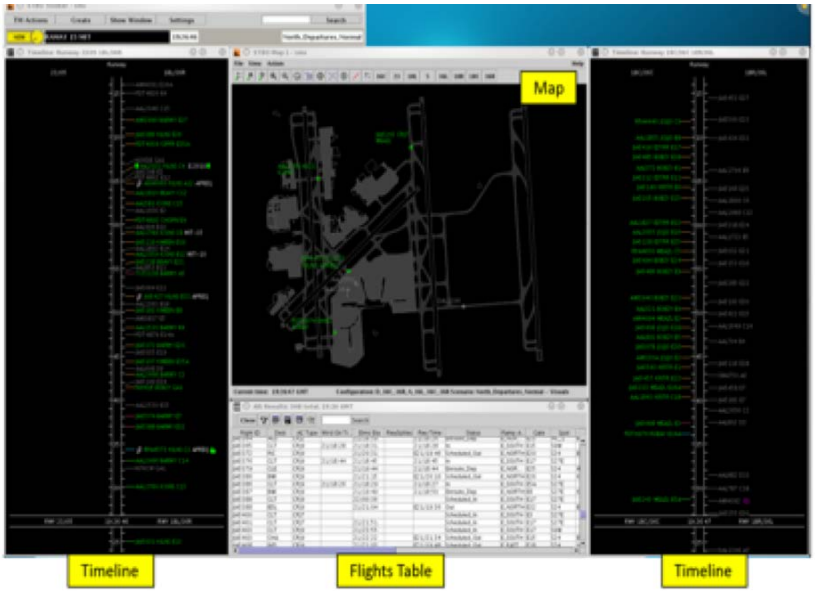

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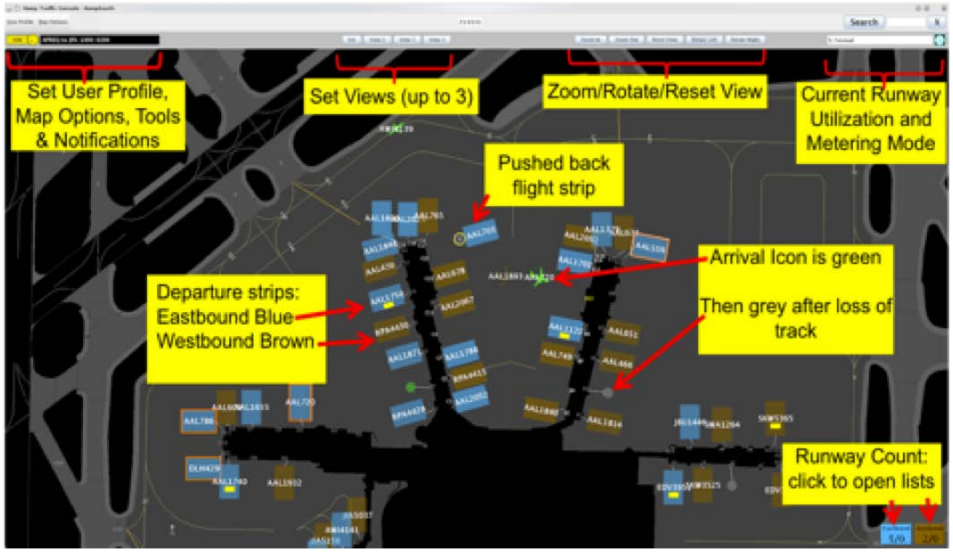

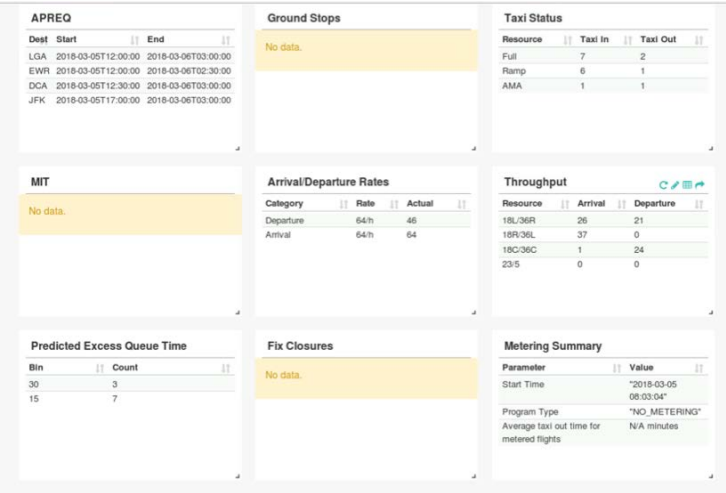

DASH – Data Analysis and System Health

What If System

Backend Infrastructure Refinements

- Refinements in ingestion of data from FAA SWIM feeds and the associated mediation logic

- Development of the TTP SWIM Prototype:
  - Created the services specified in the TTP interface containing TFDM Build 1 elements and some Build2 elements (i.e. FlightDataService, Operational Metrics Service, AirportInformation) along with the ability to publish to the destination topic

- Continued calibration of surface metering through improvements to the tactical scheduler algorithm

Matching Data from Many Feeds to a Flight

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- As the IADS system parses in data from a variety of disparate sources, both FAA SWIM feeds and industry feeds, the correlation of these data feeds to a single flight is a challenge
  - Developed a series of flight mediation rules to enable sorting through duplicate and inconsistent sources of data

- To facilitate this matching a Globally Unique Flight Identifier (GUFI) is created for a flight and then as new data emerges it is used to match to either an existing GUFI or is used to create a new GUFI

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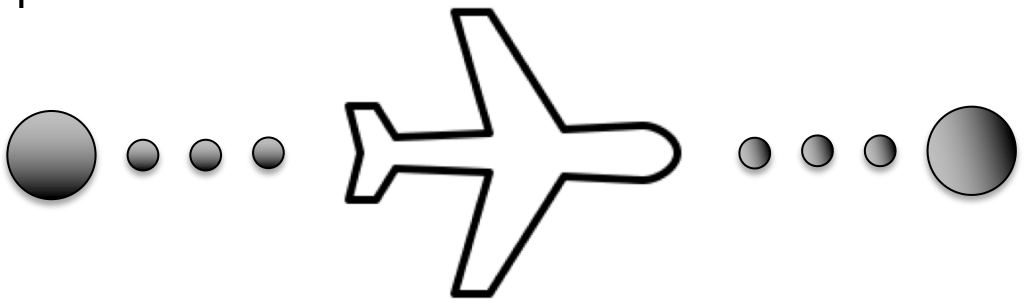

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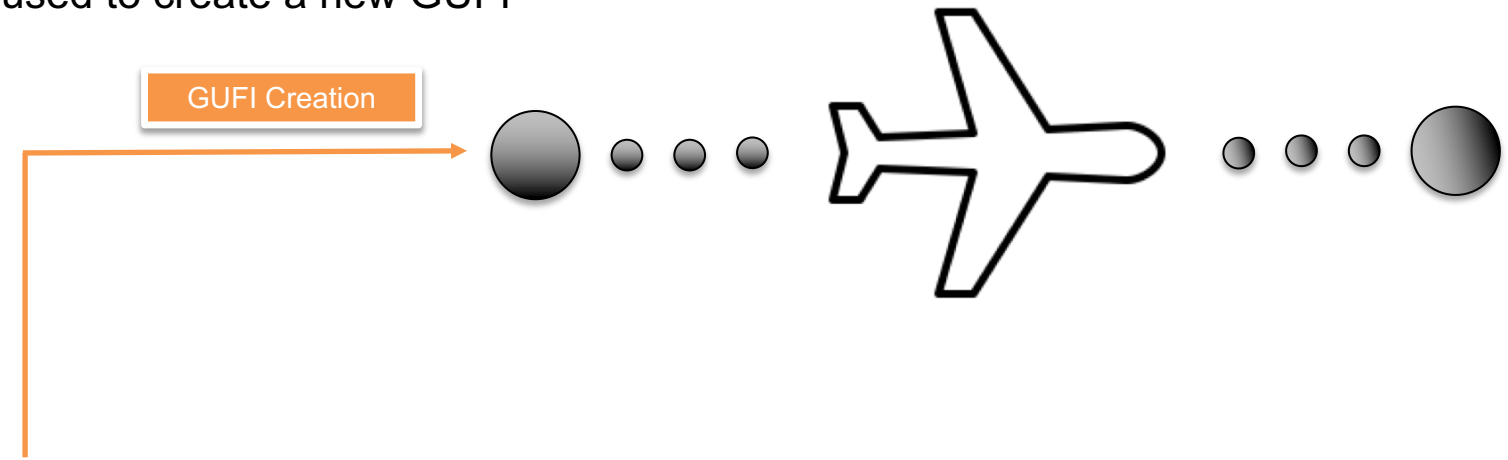

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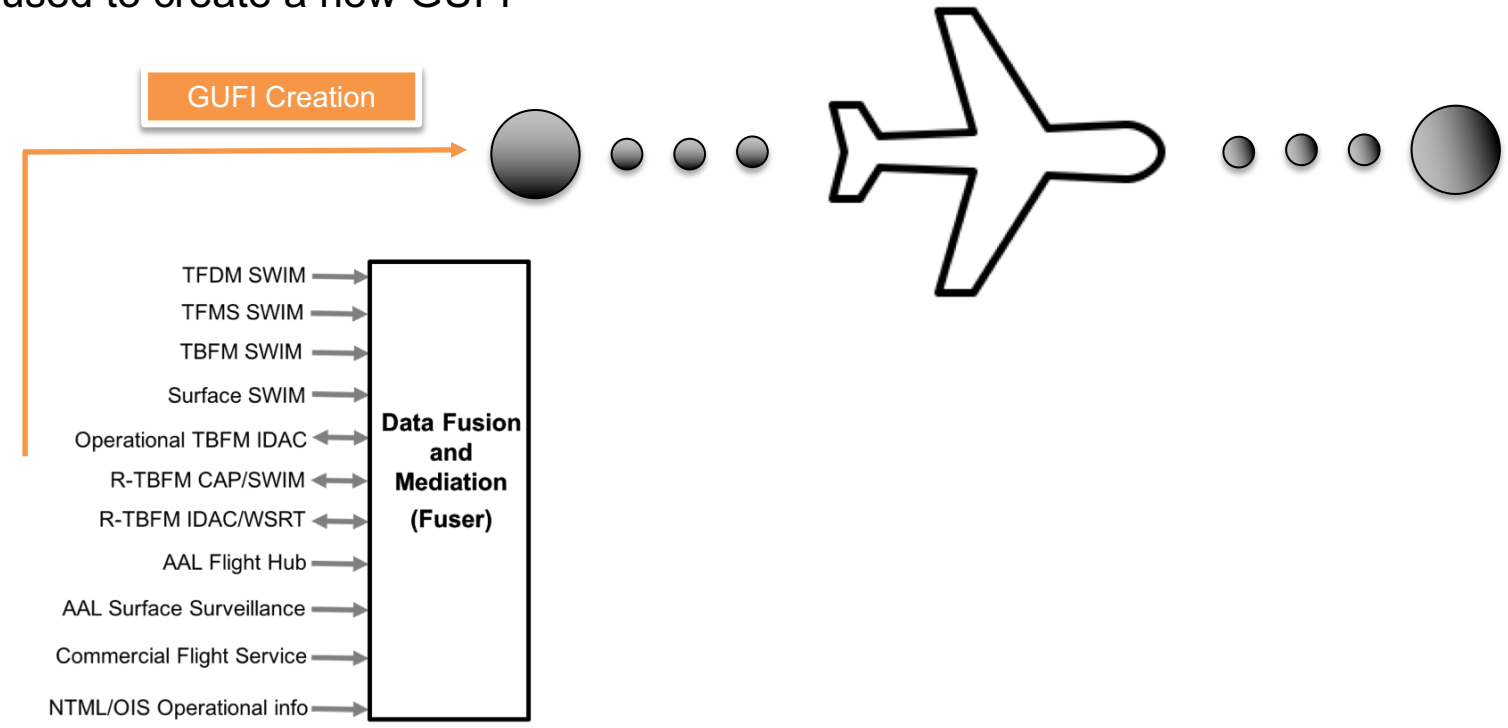

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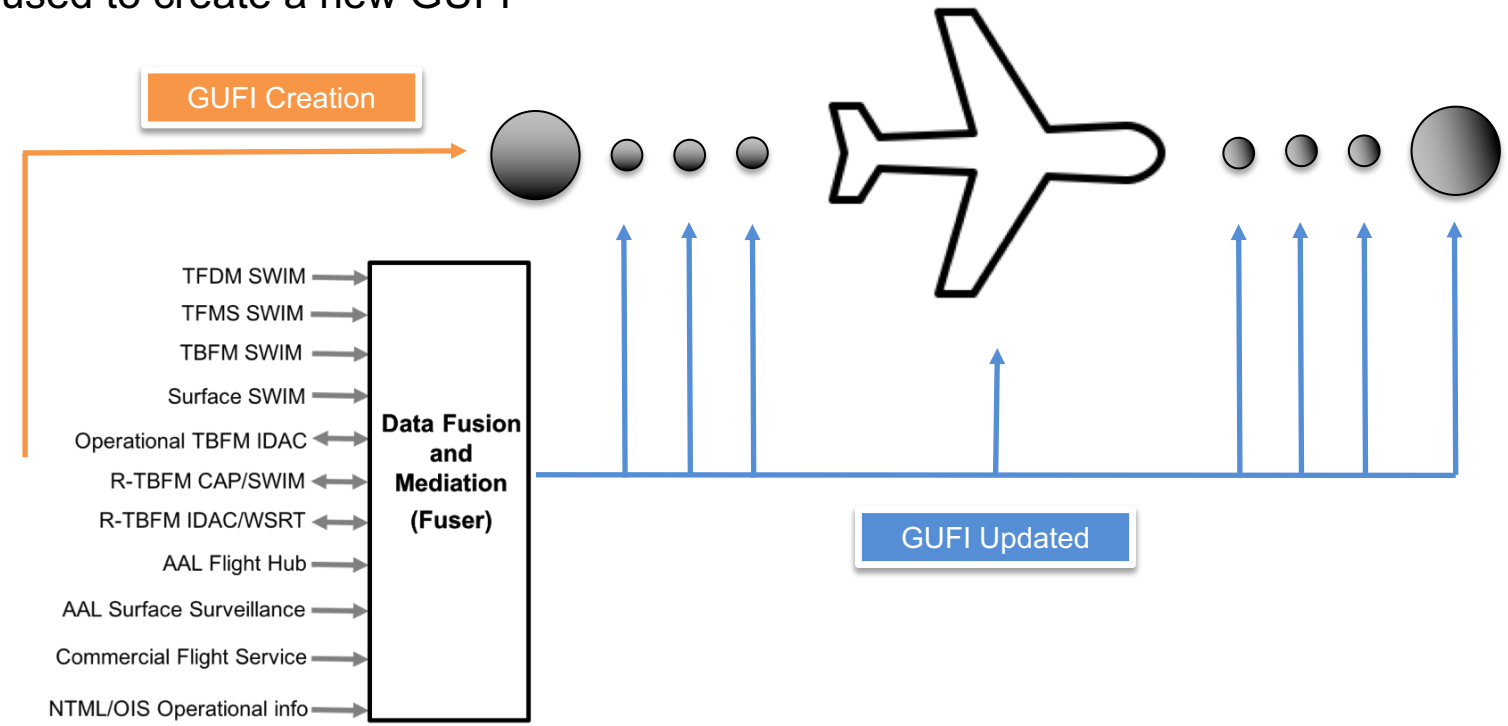
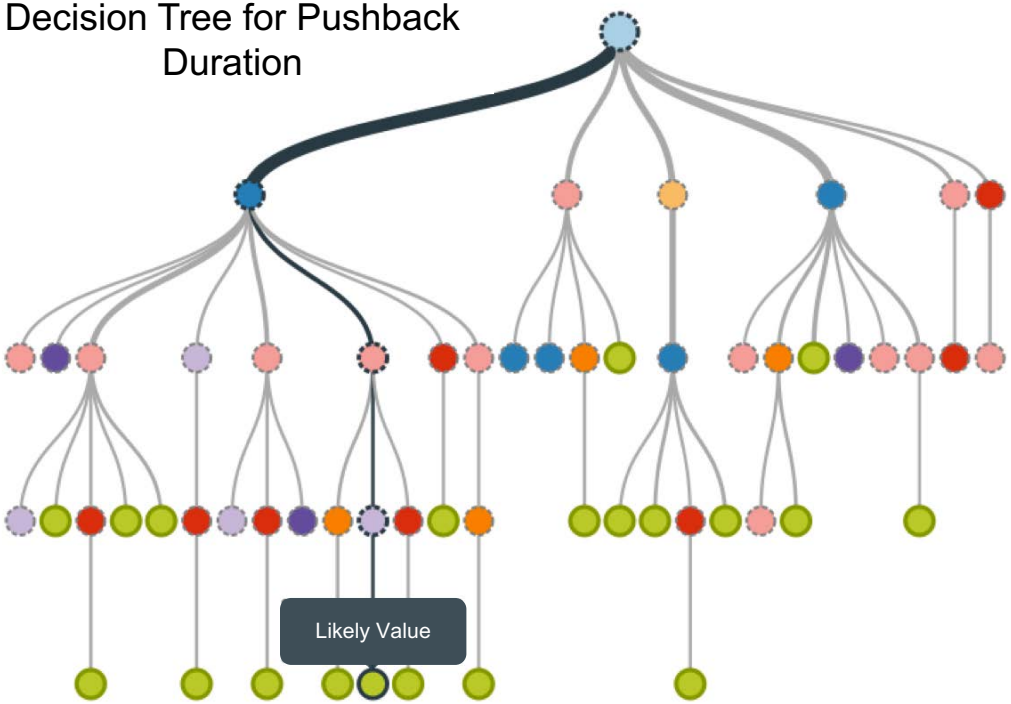
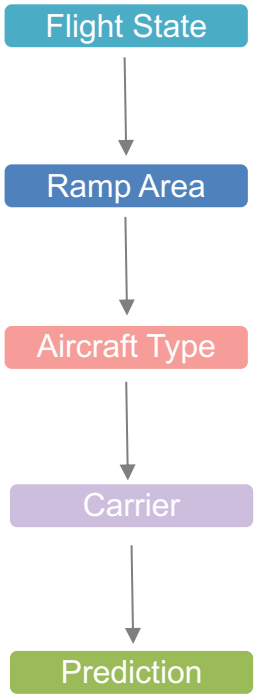


Refinements to Adaptation and Prediction Models

- A series of decision trees are leveraged to generate predictions for:
  - Pushback Duration
  - Taxi speeds for both departures and arrivals
  - Spot
  - Gate
  - Departure/Arrival Fixes
  - Departure/Arrival Runways
  - Coded Taxi Routes
- These predictions are continuously assessed and have been refined

Decision Tree for Pushback Duration

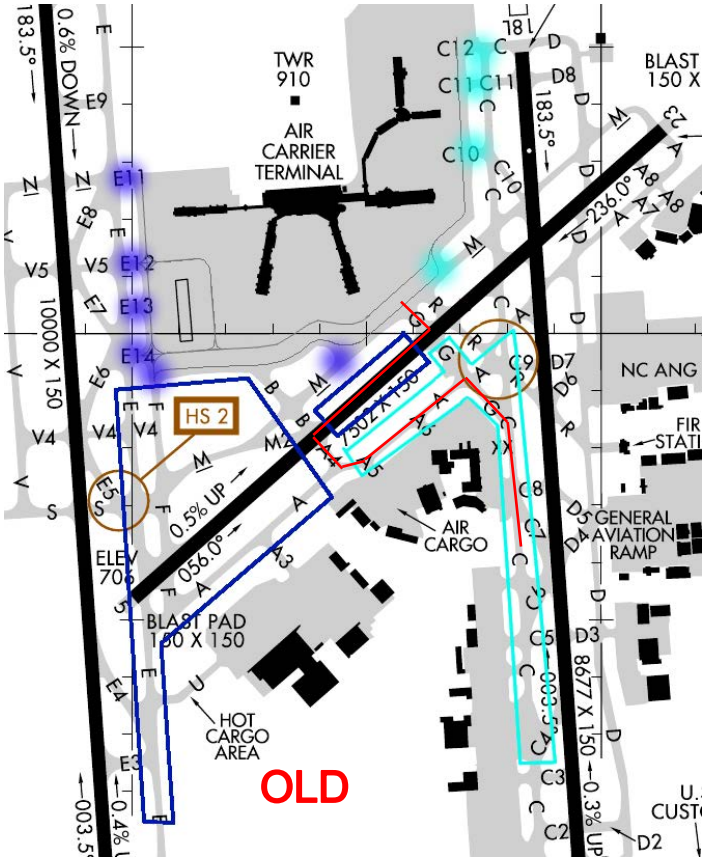


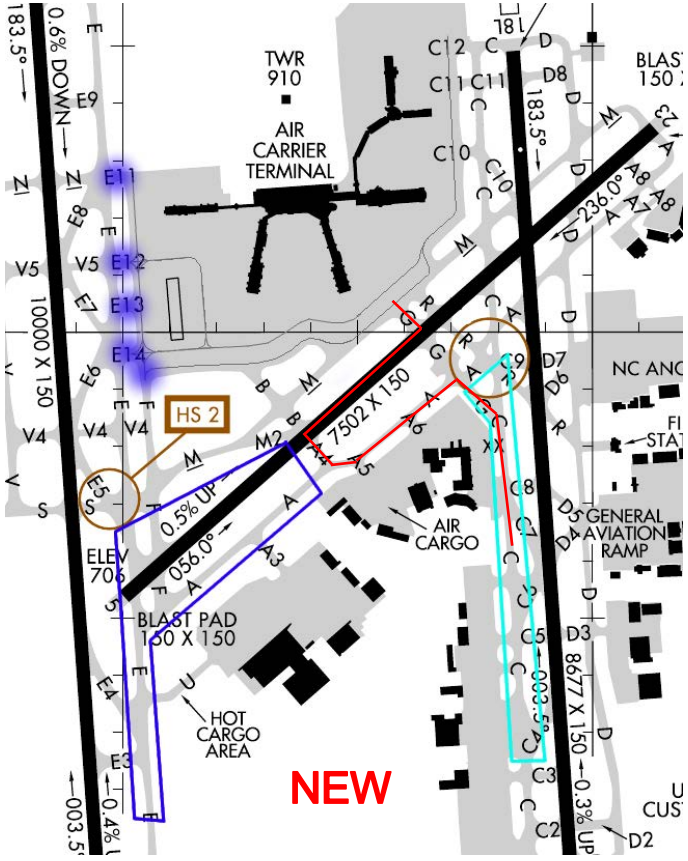


Refinements to Adaptation Detection Polygons

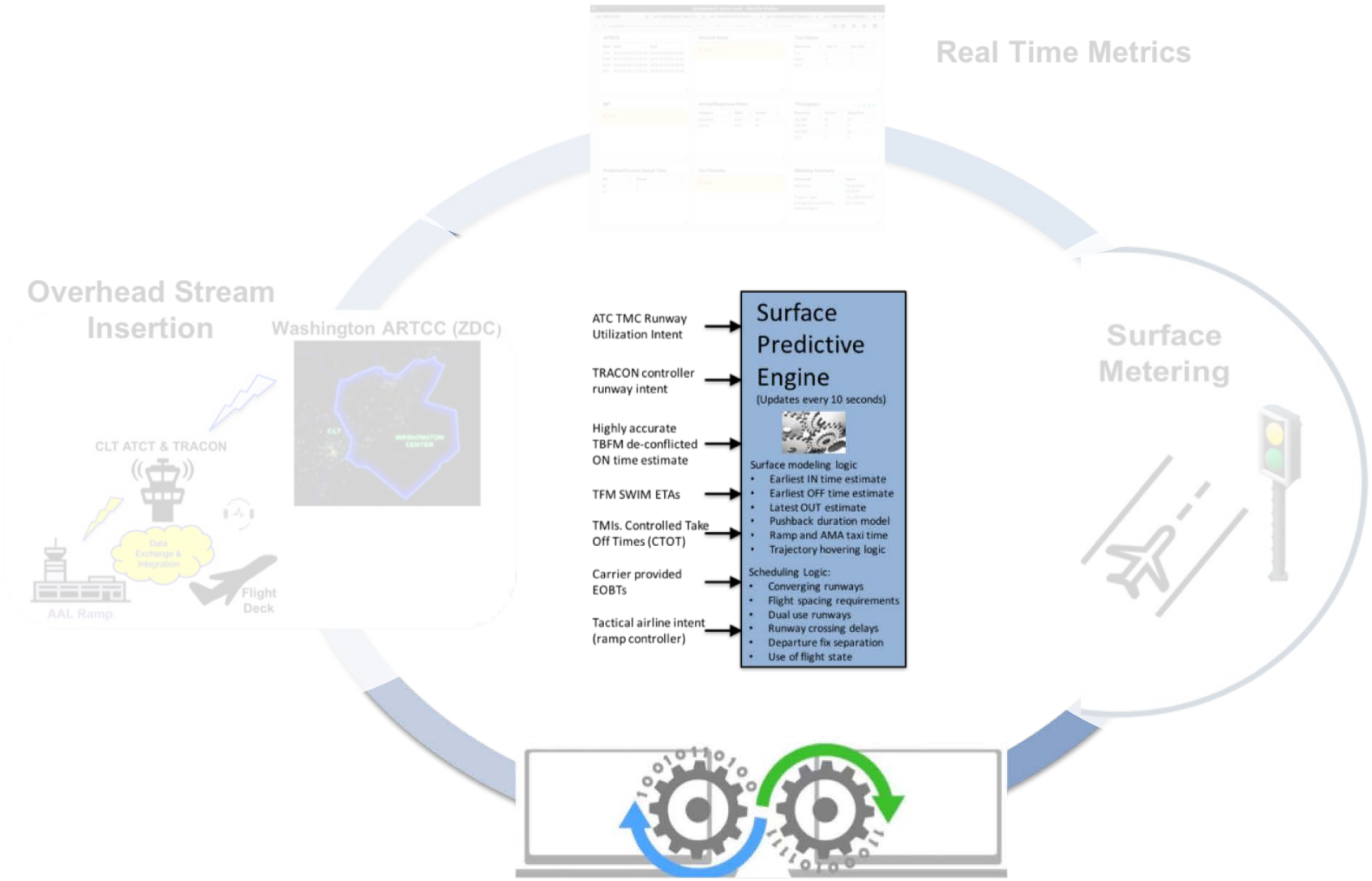
- Detection polygons are leveraged to ensure predictions are updated as an aircraft moves on the surface of the airport

- These polygons have been updated to reflect operations as well as keep pace with construction activities





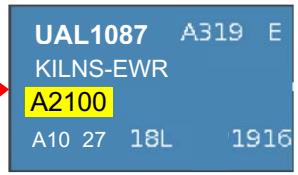
IADS Phase 1 Capabilities – Data Exchange & Integration



Initial ATC/Operator Data Exchange and Integration

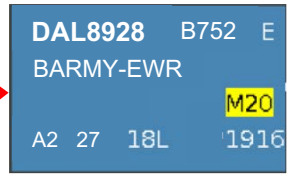
ATC to Operator

APREQ



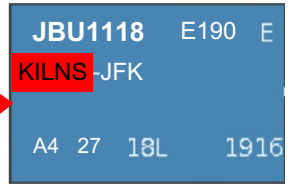
EDCT

MIT

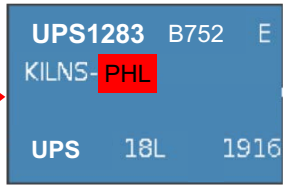


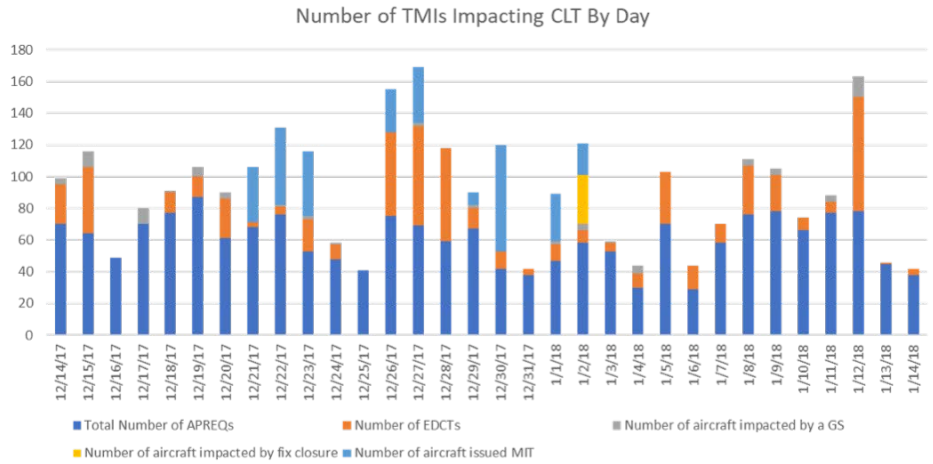
ATC Runway Change

Dep Fix Closure



Airport Stop



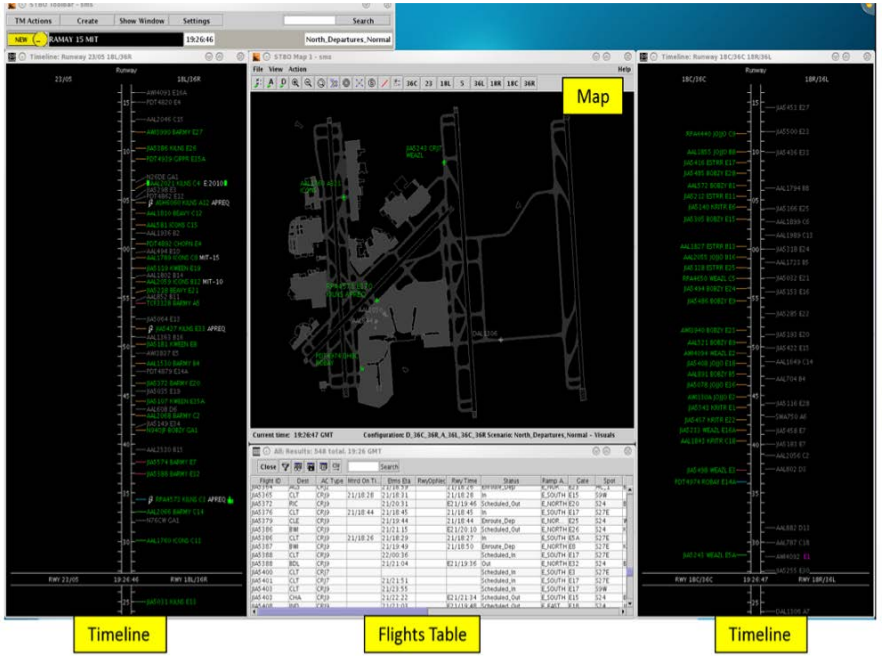


Operator to ATC

Use of EOBTs in Surface Planning

EOBT prediction, LGTD prediction and actual OUT at:

- 10m prior. 40.9% more accurate w/17.6% more predictability
- 15m prior. 27.8% more accurate w/8.7% more predictability
- 20m prior. 35.1% more accurate w/6.7% more predictability
- For 25 minutes and greater. EOBTs and LGTDs are equal



Better gate conflict information

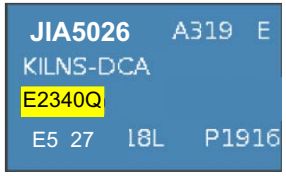
Better runway intent information

Data shown from 12/14/17 to 01/14/18

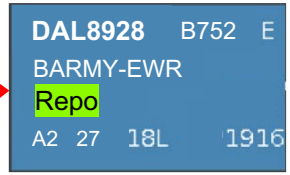
Additional Data Exchange and Integration Elements

Integrated new data into an intuitive display for ramp operations

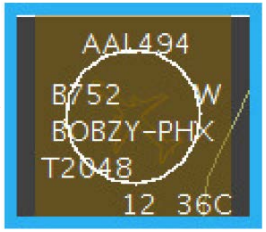
APREQ & EDCT



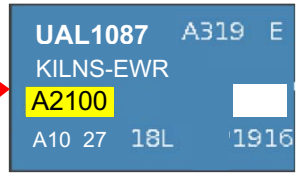
Reposition



757 Indication



Scratch Pad Indication

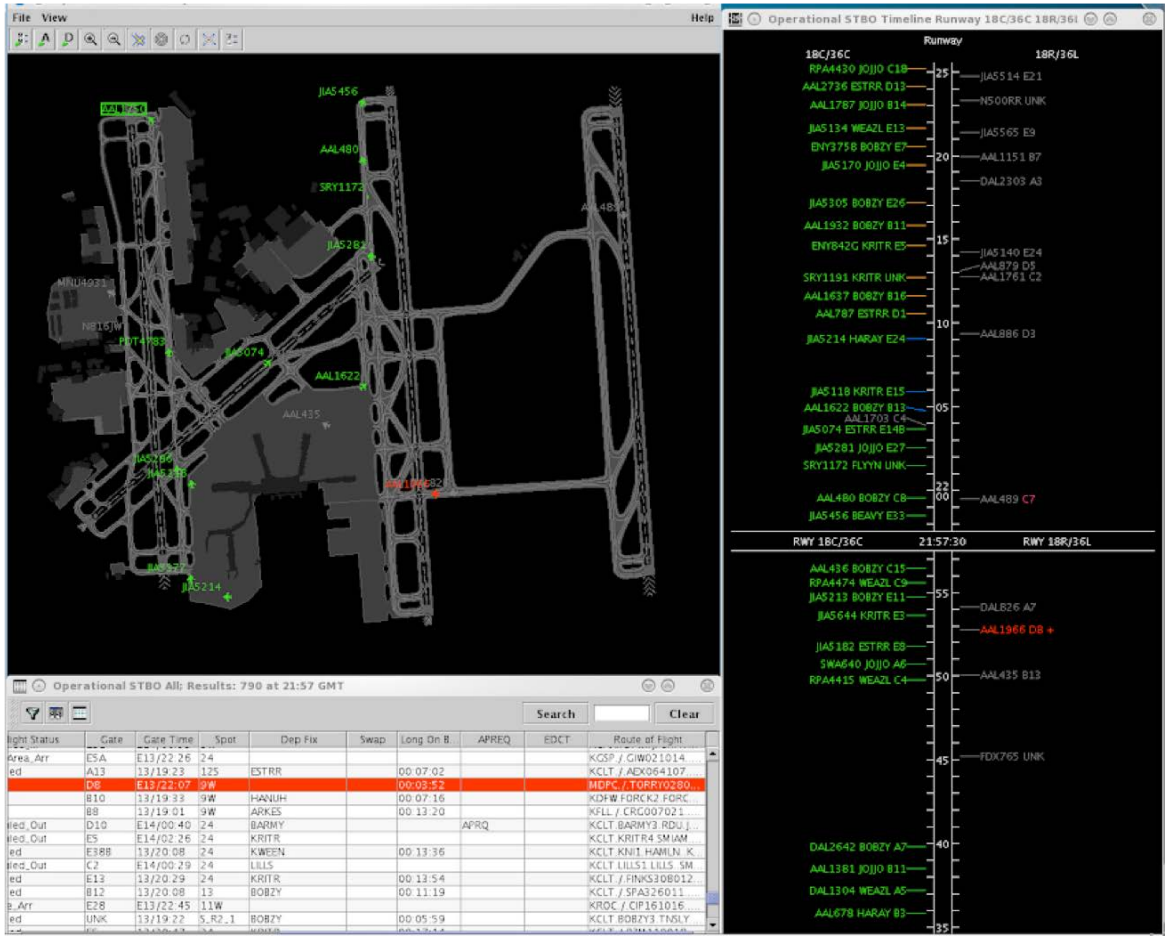


Additional Data Exchange and Integration Elements

- Ability to indicate a flight as a medical emergency on either the ATC tool or ramp tool

- This information is then conveyed in an intuitive manner on both user interfaces

ATC TMC
STBO Client



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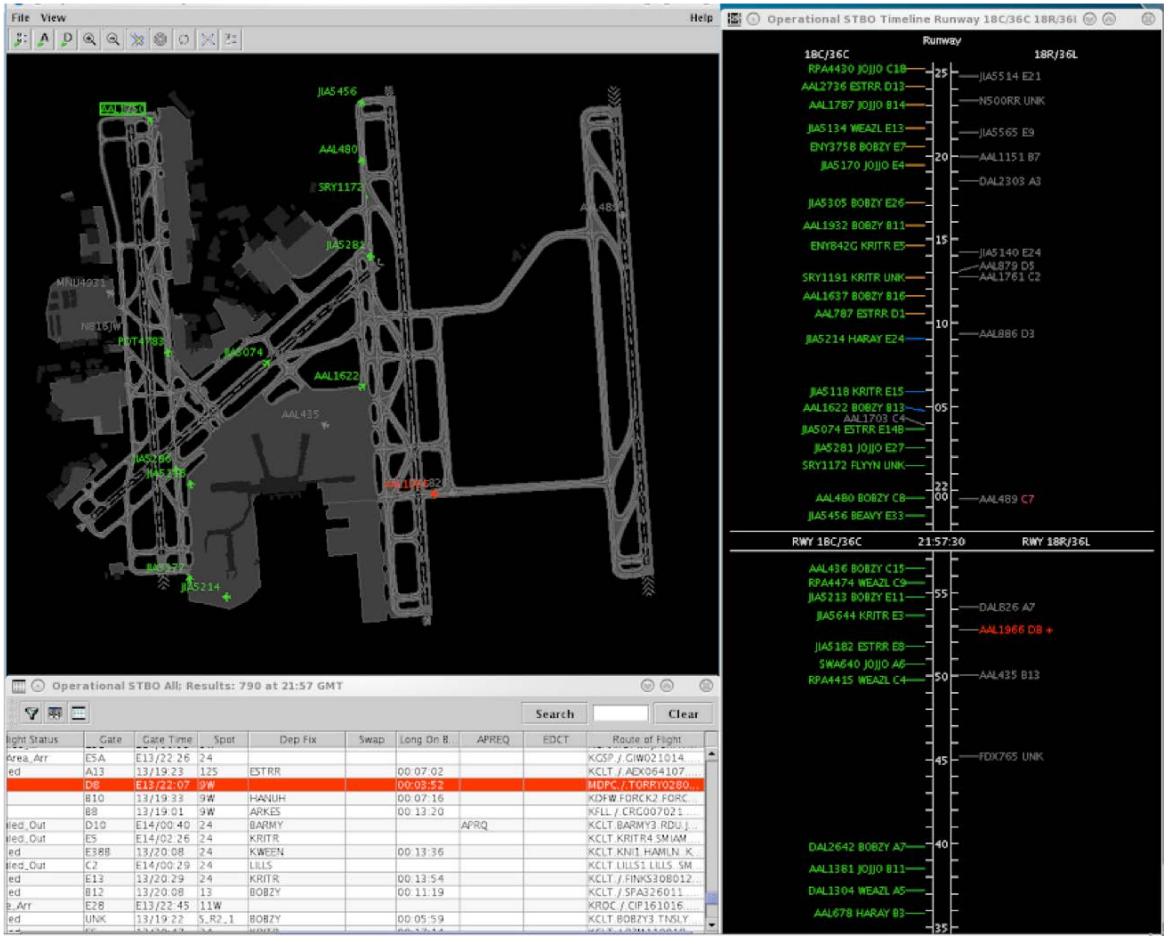

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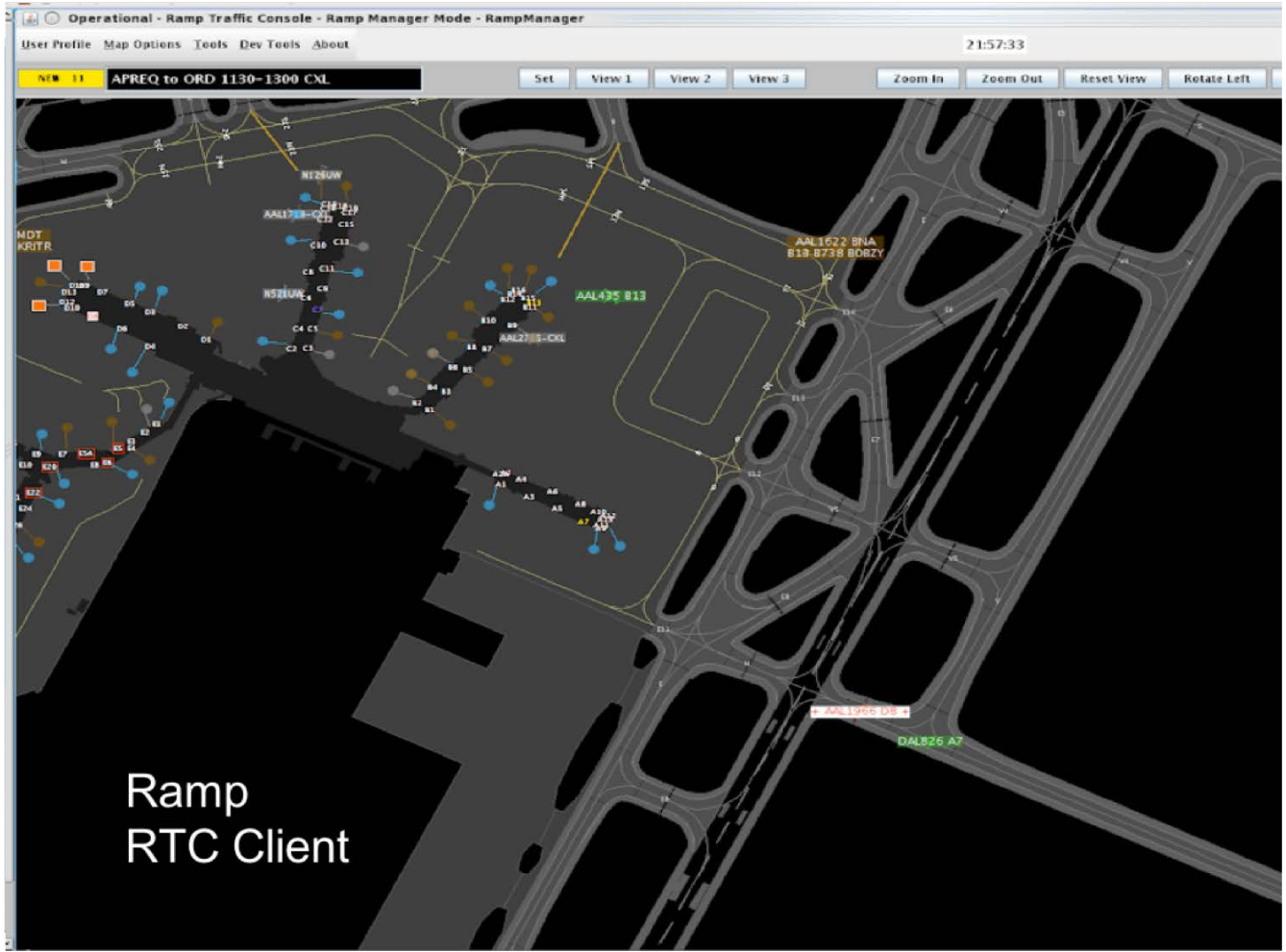
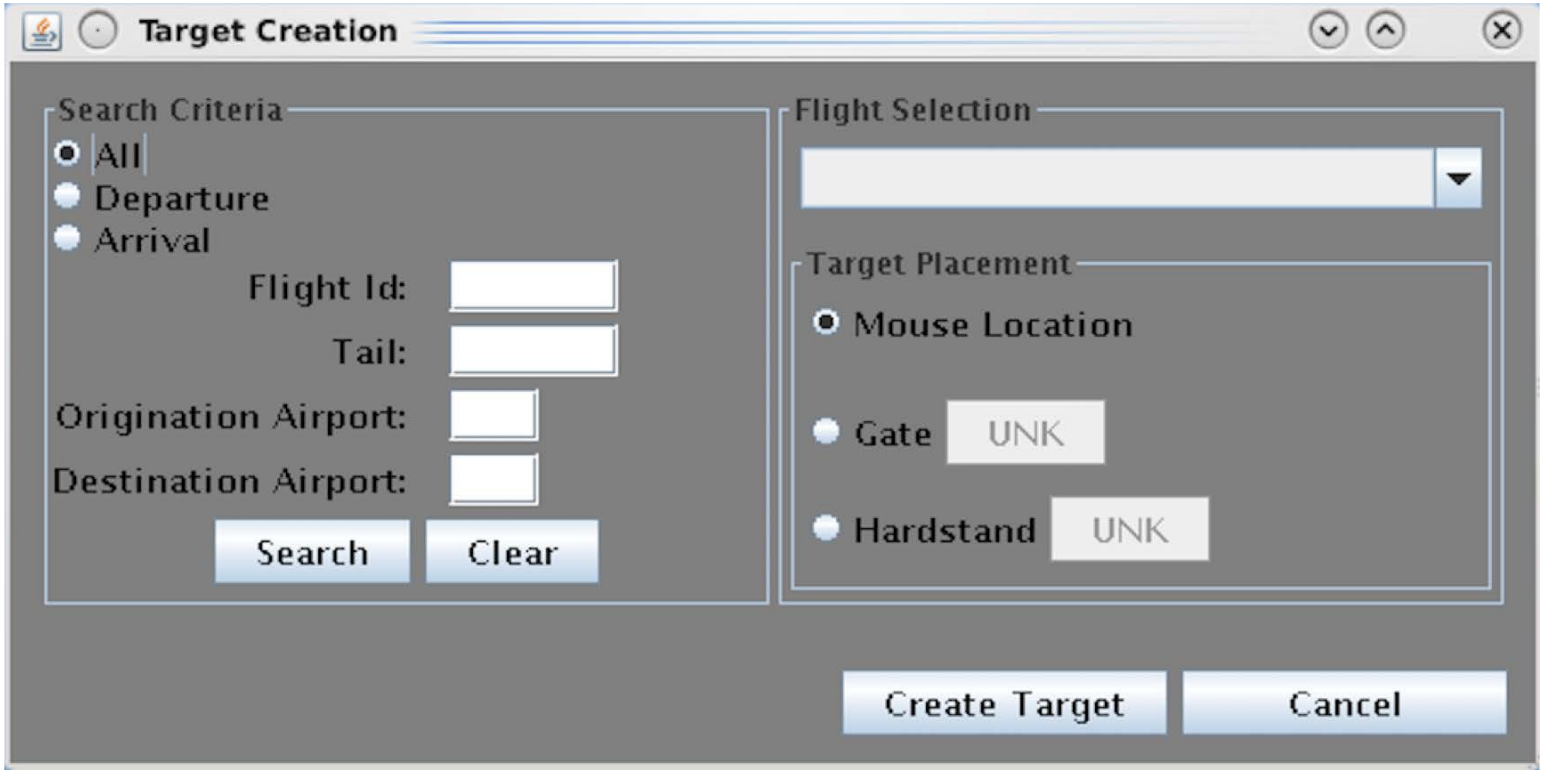


Additional Data Exchange and Integration Elements – Adding a Target

- The need for users to add a target if the flight was not generated was also identified and incorporated into the system

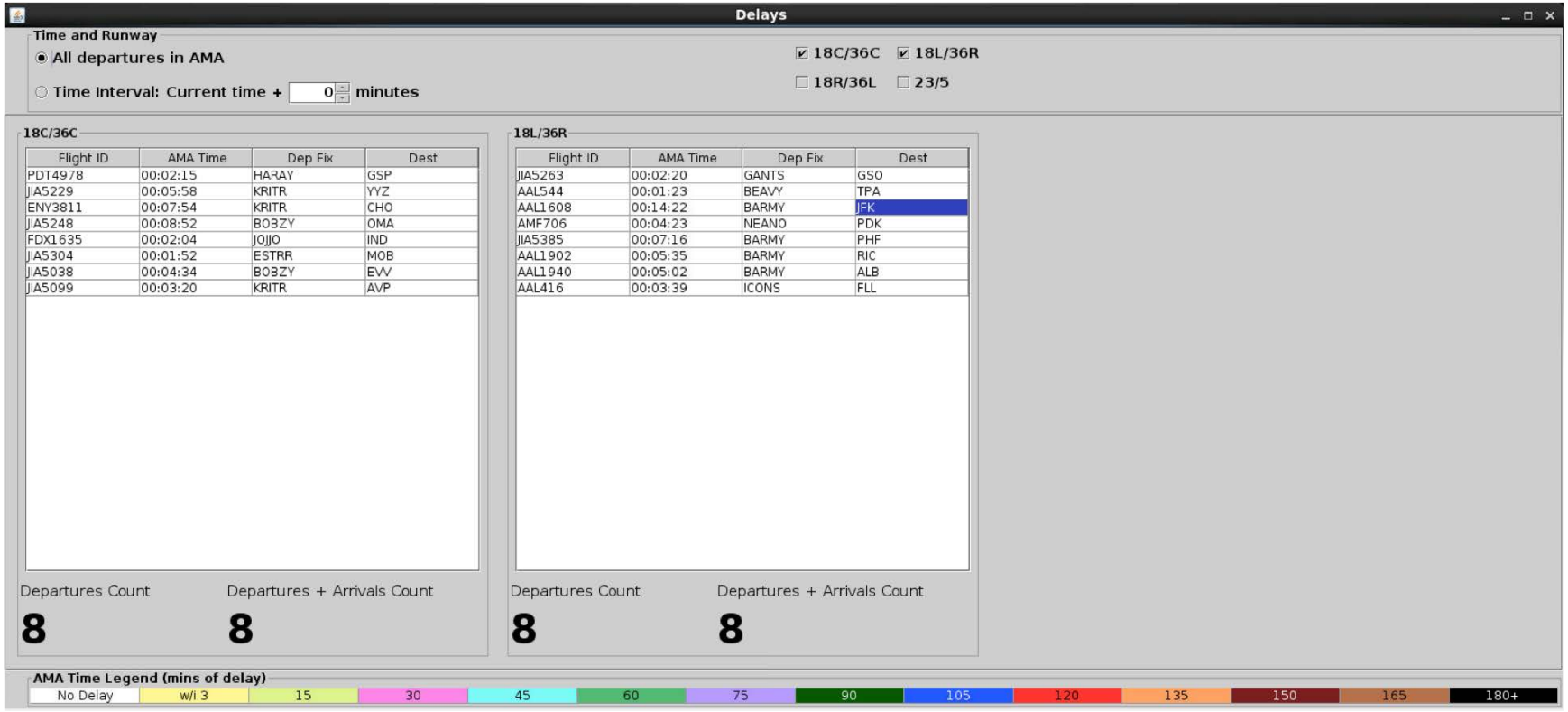
- This capability is part of a larger effort to address the concept of having the IADS system reflect airframes for situational awareness



Incorporating ARMT Features in the IADS System

- With ARMT planned to be subsumed into TFDM, several of the capabilities in this tool are being incorporated into the IADS system
  - Working on integrating this data in an intuitive fashion to enable tools to assist with load balancing

Taxi List



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Departure Fix Status Table

Operational STBO Departure Fix Status Window - 02:46 GMT

	ANDYS	BARMY	BEAVY	BOBZY	BUCKL	CEGAL	DEBIE	ESTRR	FLYYN	GANTS	GIPPR	HAMLN	HARAY	ICONS	JOJJO	JOTTA	KILNS	KRITR	KWEEN	LILLS
MIT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fix Status																				
Count	0	3	1	5	0	0	0	4	0	1	0	0	1	6	2	0	2	6	0	2
Avg Dly	0	6	2	4	0	0	0	5	0	3	0	0	4	3	5	0	2	5	0	3
Max Dly	0	12	2	11	0	0	0	9	0	3	0	0	4	4	7	0	3	12	0	4
0-15 min		AAL1608 AAL1940	AAL544	JIA5038				JIA5333 JIA5304		JIA5263			PDT4978	AAL1564 JIA5141 AAL2035 AAL416	JIA5395 FDX1635		AAL2701	JIA5229 JIA5585 AAL1794 JIA5099		PDT4937 AAL330
16-30 min				AAL1766 AAL2766 JIA5138 JIA5238				RPA4390						JIA5474 AAL2012			AAL1987	AAL1793 AAL1702		
31-45 min			JIA5186 JIA5349	JIA5224 AAL1854				AAL2483							JIA5109 AAL623		AAL1904		JIA5161	AAL2090 JIA5567
46-60 min																	JIA5503	JIA5150		

ATC/Operator Data Exchange and Integration Lessons

Lessons Learned from the Operational Field Evaluation

- For EOBTs, there are challenging tradeoffs between stability (update frequency) and accuracy. There are many uses of EOBTs, some with competing goals. What are the most important EOBT metrics that Operators can use as a guideline?
- Procedures for handling early display of overhead stream scheduling (“wheels up”) can be situational. When delays are large, the procedure may be different than smaller delays.
- The importance of good gate conflict detection can’t be overstated. This in turn leads to the need for high quality arrival data, and some manual inputs to keep up with untracked flights
- Integrating new data into an intuitive display for ramp operations is non-trivial for both software and procedures. The ramp traffic console in operational use at CLT has a number of ‘best practices’ integrated from these lessons.
- Accentuating the difference between restrictions due to surface congestion versus those due to overhead stream is challenging, but required
- Associating flights across FAA and Operator systems has revealed areas where flights may not be properly associated. These are largely invisible to current day systems due to segmentation in domains and tools.

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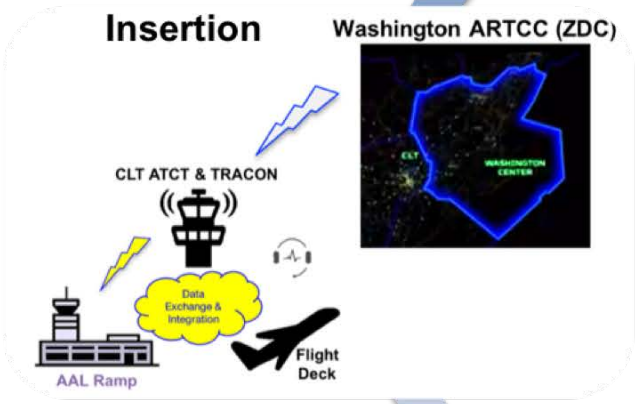
IADS Phase 1 Capabilities – Overhead Stream Insertion

Real Time Metrics

Surface Metering

Data Exchange & Integration

Overhead Stream Insertion



ATC TMC Runway Utilization Intent

TRACON controller runway intent

Highly accurate TBFM de-conflicted ON time estimate

TFM SWIM ETAs

TMIs. Controlled Take Off Times (CTOT)

Carrier provided EOBTs

Tactical airline intent (ramp controller)

Surface Predictive Engine

(Updates every 10 seconds)

Surface modeling logic
- Earliest IN time estimate
- Earliest OFF time estimate
- Latest OUT estimate
- Pushback duration model
- Ramp and AMA taxi time
- Trajectory hovering logic

Scheduling Logic:
- Converging runways
- Flight spacing requirements
- Dual use runways
- Runway crossing delays
- Departure fix separation
- Use of flight state

Initial Electronic Overhead Stream Insertion Capabilities

- On November 1st, 2017 IDAC style negotiation with ZDC was introduced
  - CLT ATCT has been actively using STBO to electronically negotiate APREQ times (86% of all ZDC flights)
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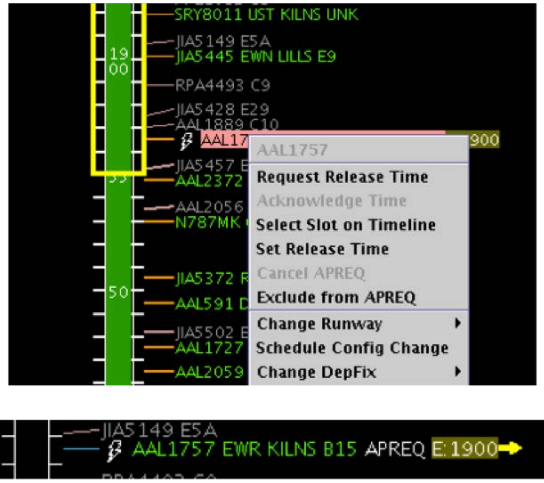
STBO at CLT ATCT



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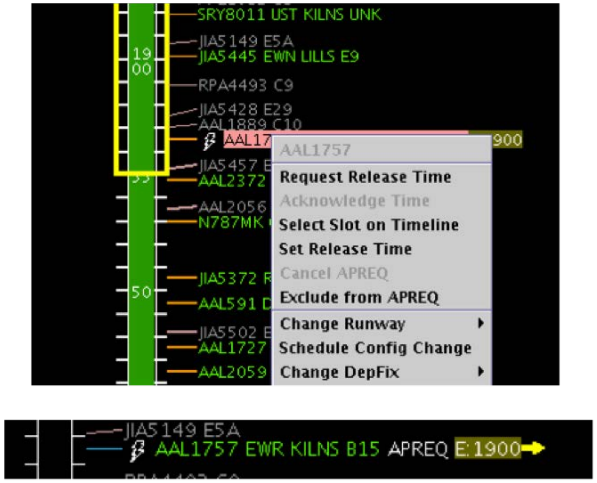
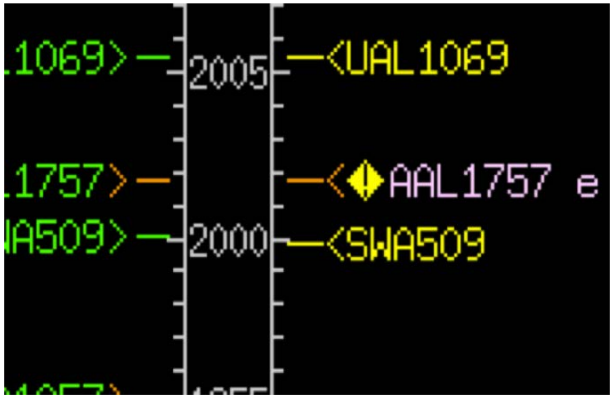


TBFM at ZDC



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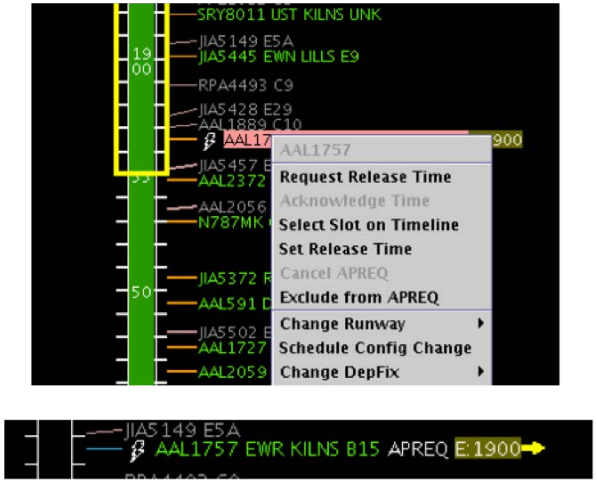

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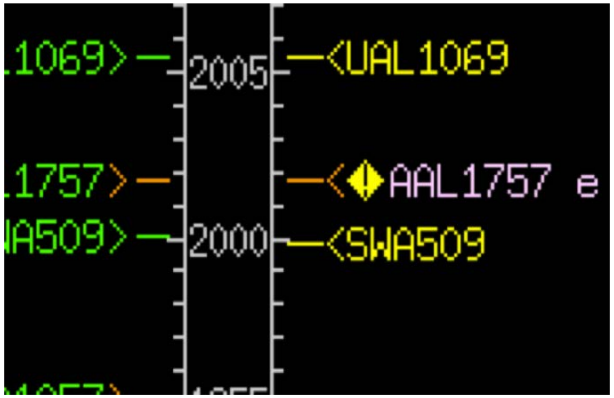
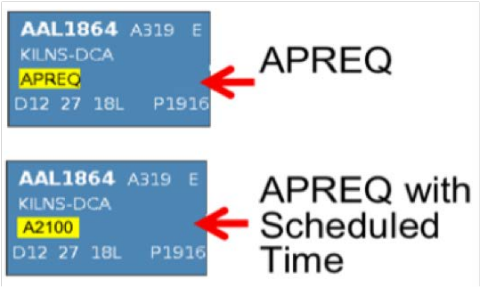
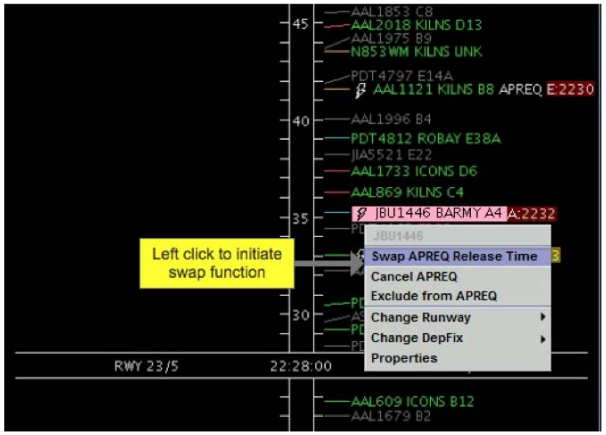


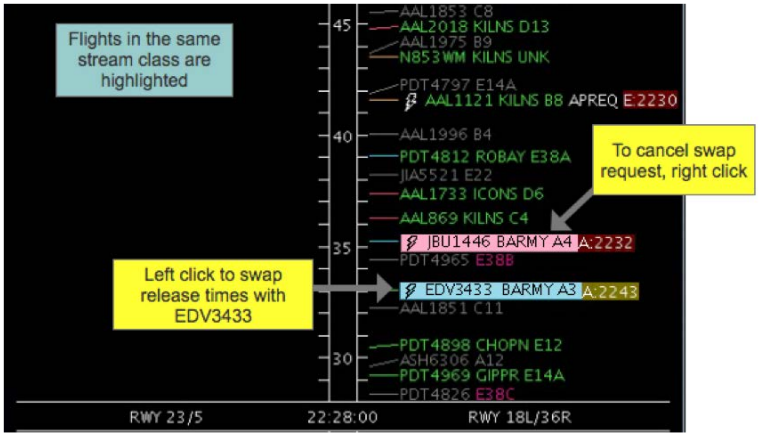
RTC at CLT AAL Ramp



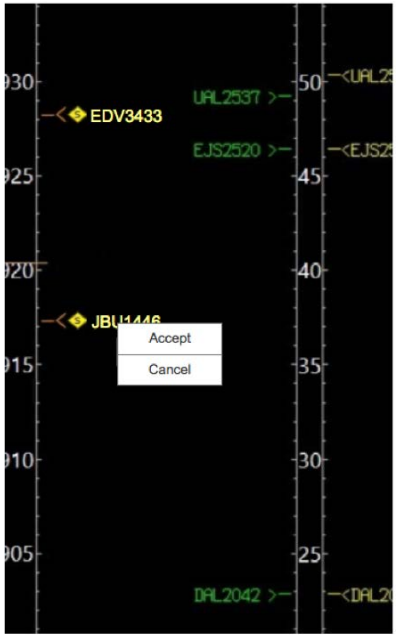
Additional Electronic Overhead Stream Insertion Capabilities - Swaps

STBO at CLT ATCT

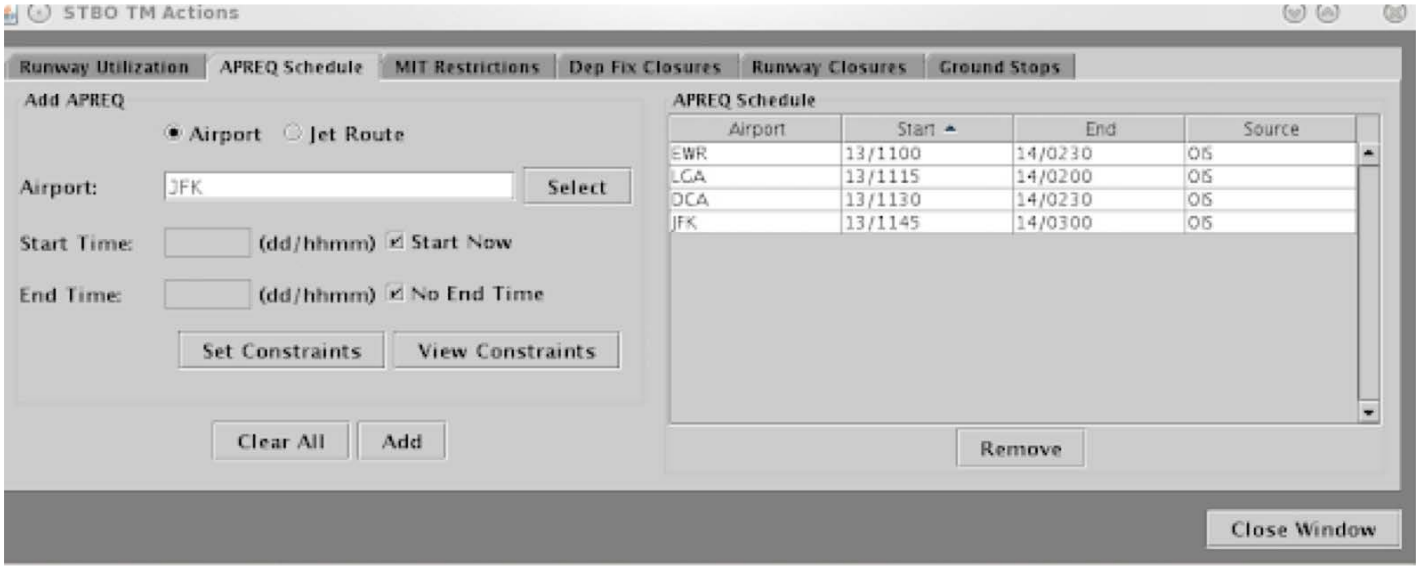




TBFM at ZDC



Additional Electronic Overhead Stream Insertion Capabilities - Flight Exclusions/Inclusions



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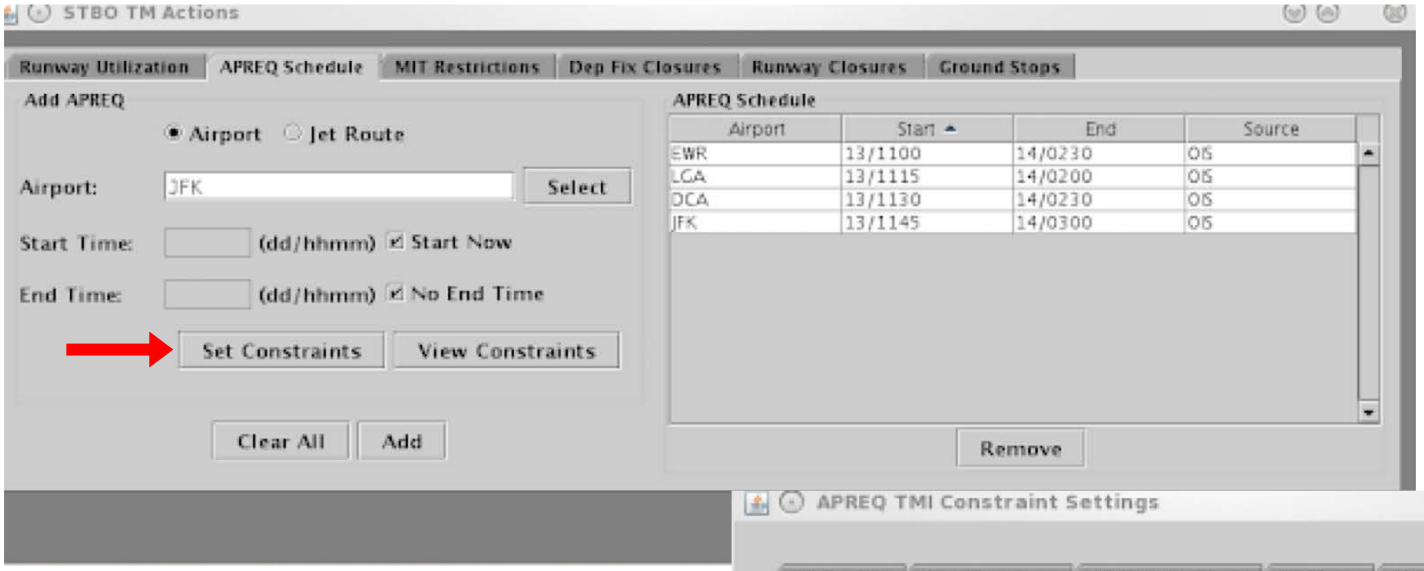
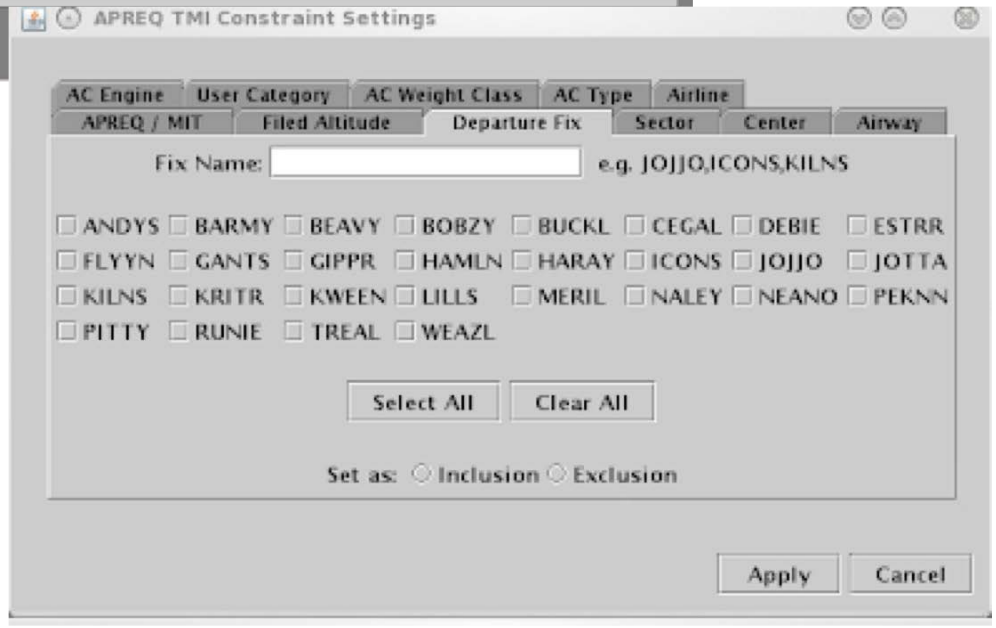
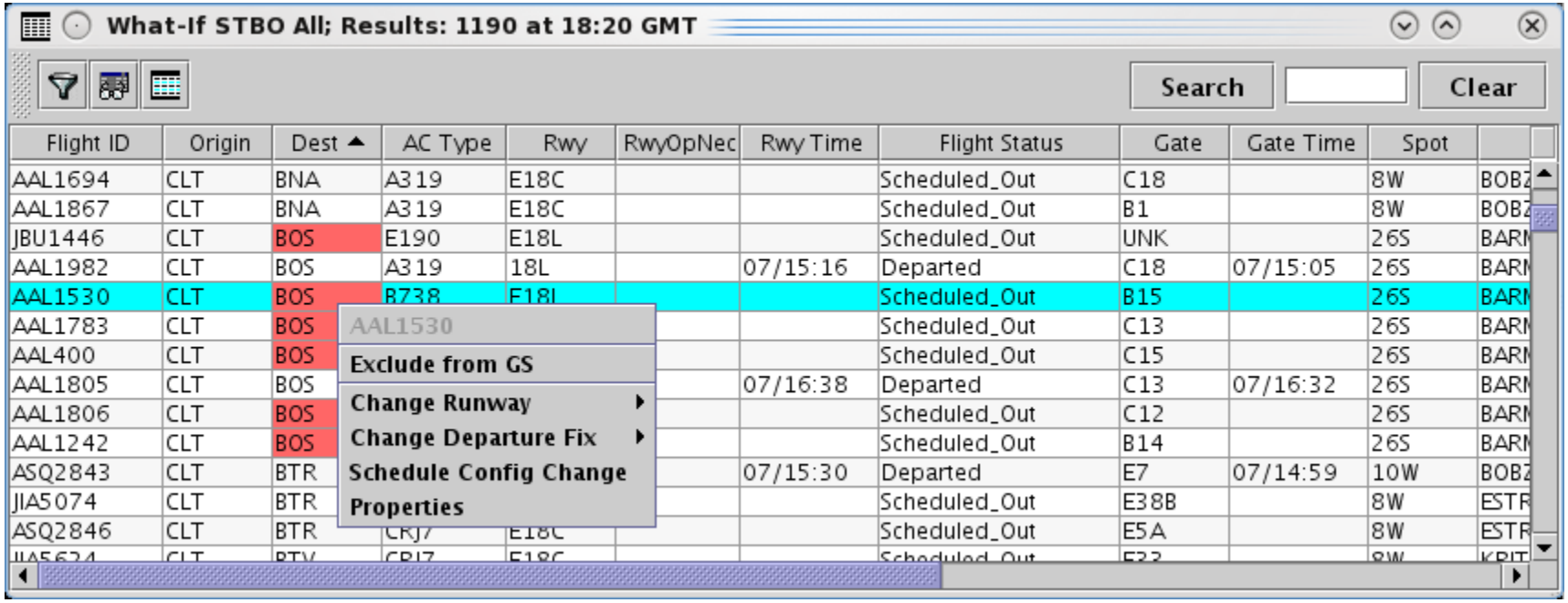




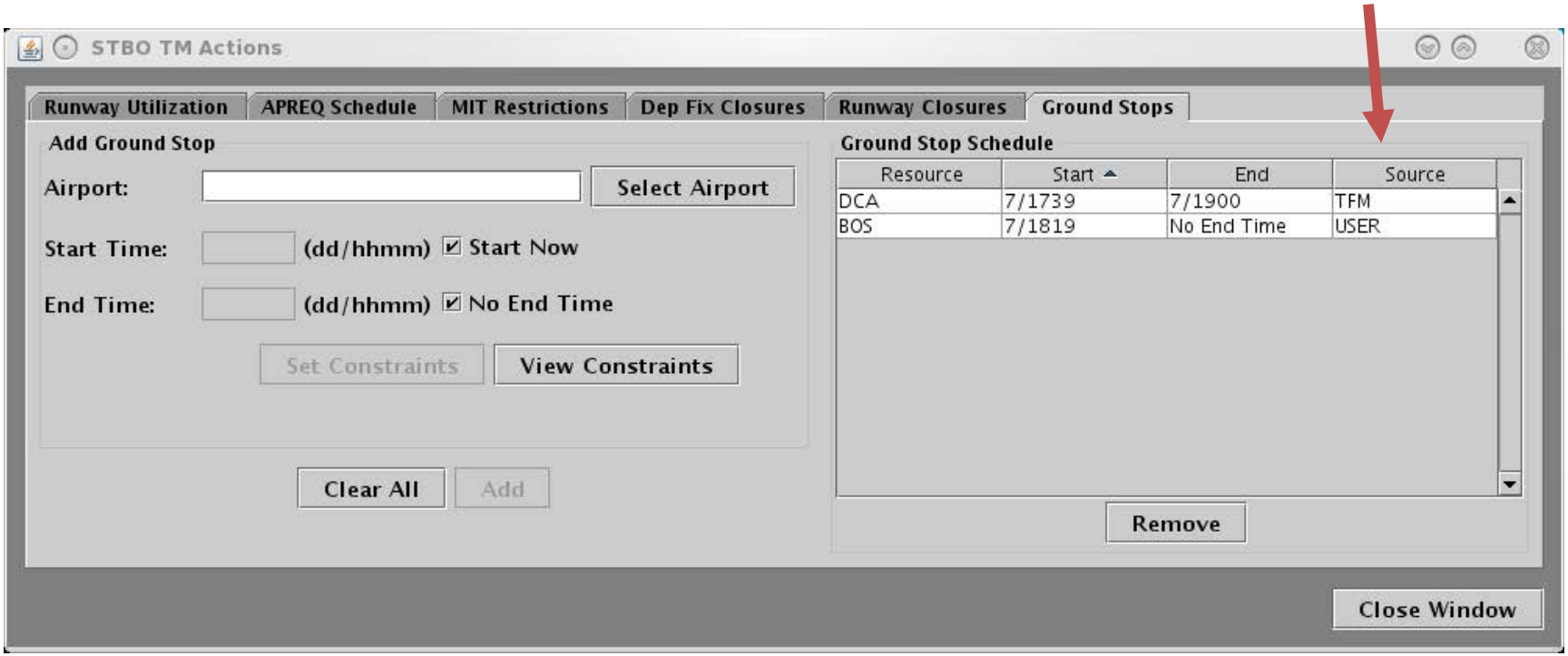
Additional Electronic Overhead Stream Insertion Capabilities - Single Flight Exclusions

Single flight exclusions from a Ground Stop TMI and Departure Fix Closure TMI available



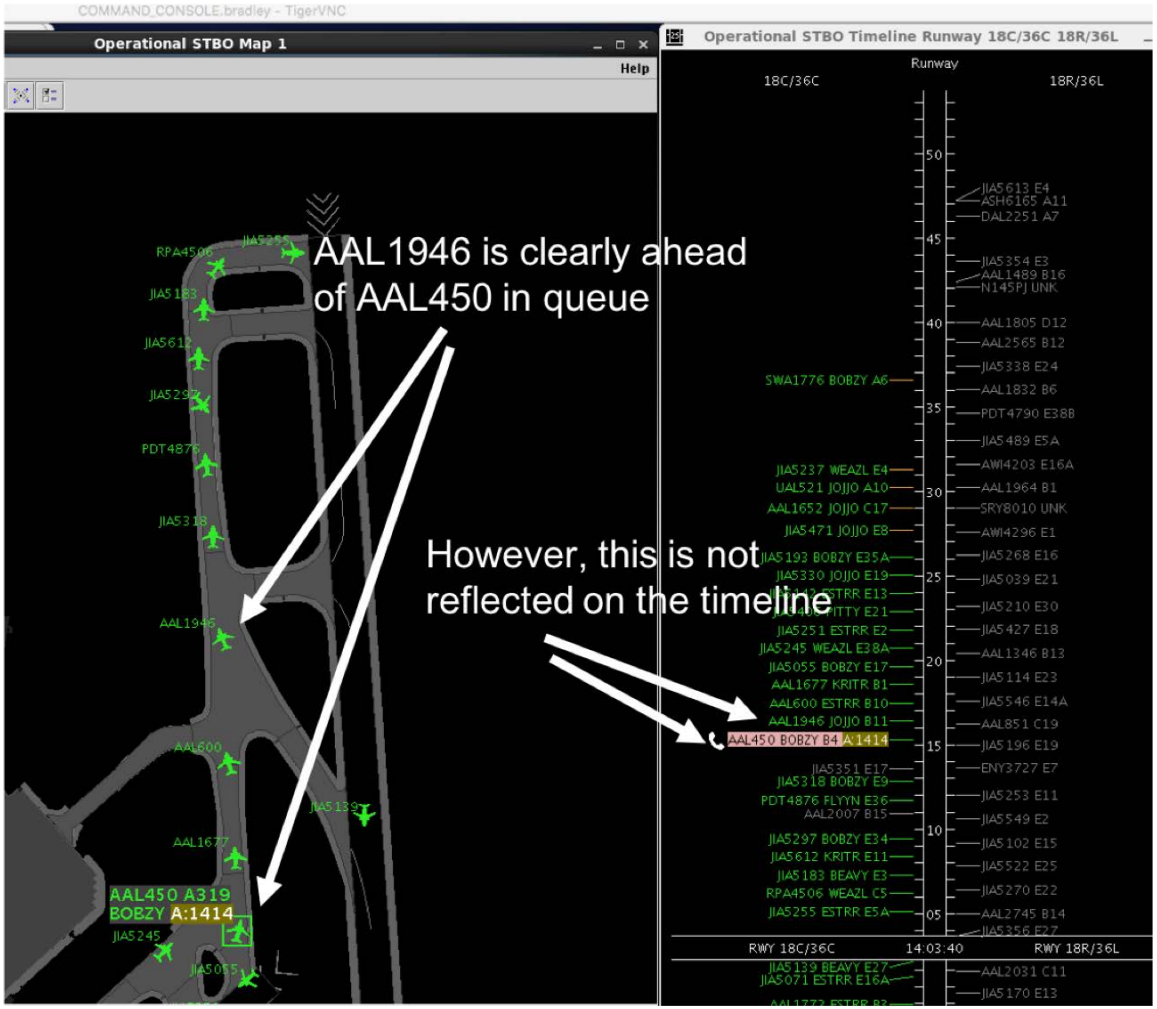
Additional Electronic Overhead Stream Insertion Capabilities - TMI Source

Added the source for MITs, Ground Stops, and Departure Fix Closures to the TM Actions panel and the Notification Table's Details.



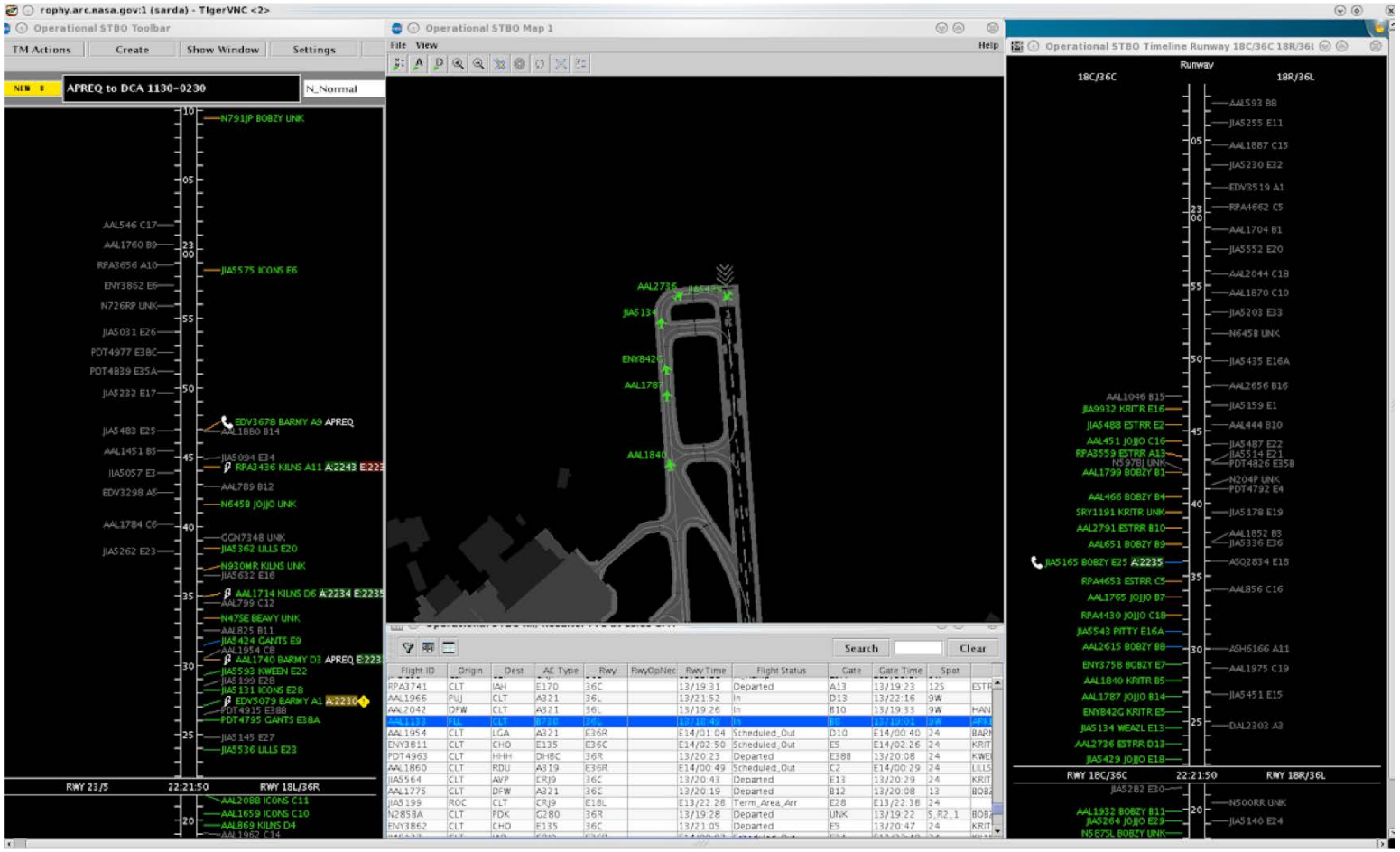
Additional Electronic Overhead Stream Insertion Capabilities – Display of Flights on the Timeline

STBO TimeLine initially displayed flights in the order in which controlled flights were scheduled not necessarily the time were actually predicted to depart



Additional Electronic Overhead Stream Insertion Capabilities – Display of Flights on the Timeline

Refined display of flights on the timeline to reflect the best estimate of when a controlled flight will actually depart by updating its actual position on the timeline after it passes the spot.



Overhead Stream Operational Integration Lessons

Lessons Learned from the Operational Field Evaluation

- Showing available overhead stream capacity (“red space, green space”) to surface planners in an integrated and intuitive manner can reduce delay.
- Look-ahead scheduling time horizon calibration is a challenging tradeoff between scheduling too early with uncertain data that can lead to re-planning, versus too late with predictive certainty but lower benefits to all.
- Taxi time calibration is a challenging tradeoff between taxi time predictions that are on the ambitious side with less delay but more re-planning, versus on the late side with less re-planning but more congestion.
- Crawl, walk, run strategy is prudent in this area at large facilities. Starting with electronic negotiation might lead to negative side effects at some facilities if EOBTs and taxi times are not calibrated, with operational procedures in place.
- Target Movement Area entry Times (TMATs) are important hand off point for FAA controlled flights. If surface metering TMATs are held equally important to FAA controlled flight, this effectively de-accentuates their importance.

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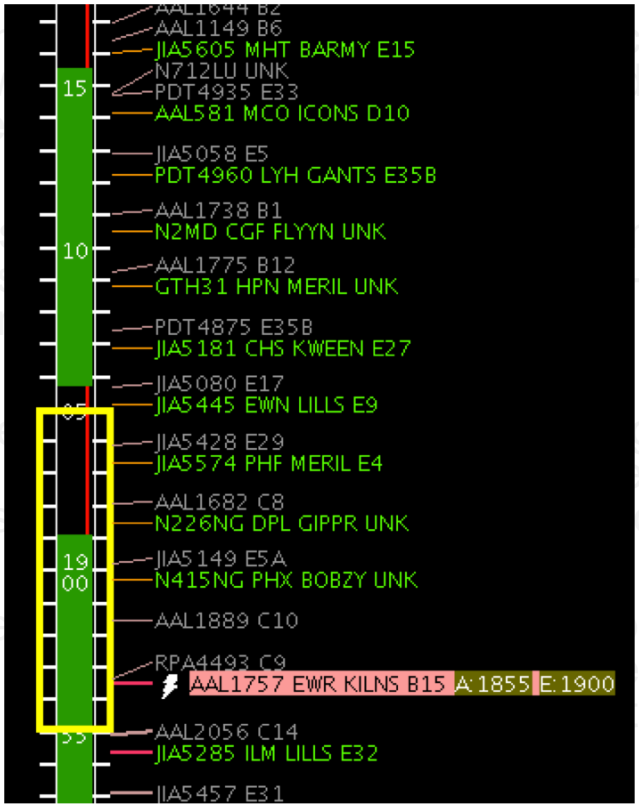
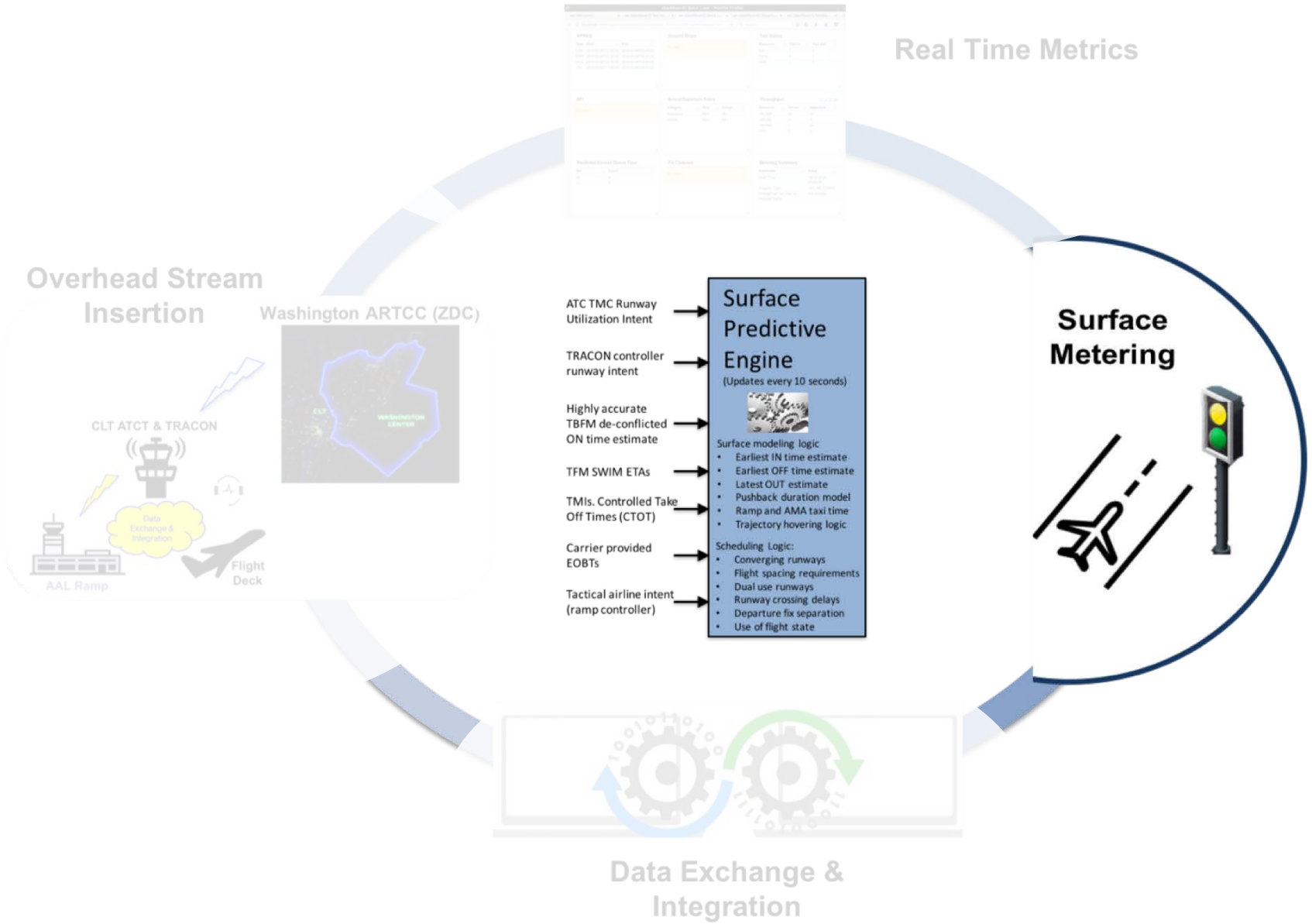
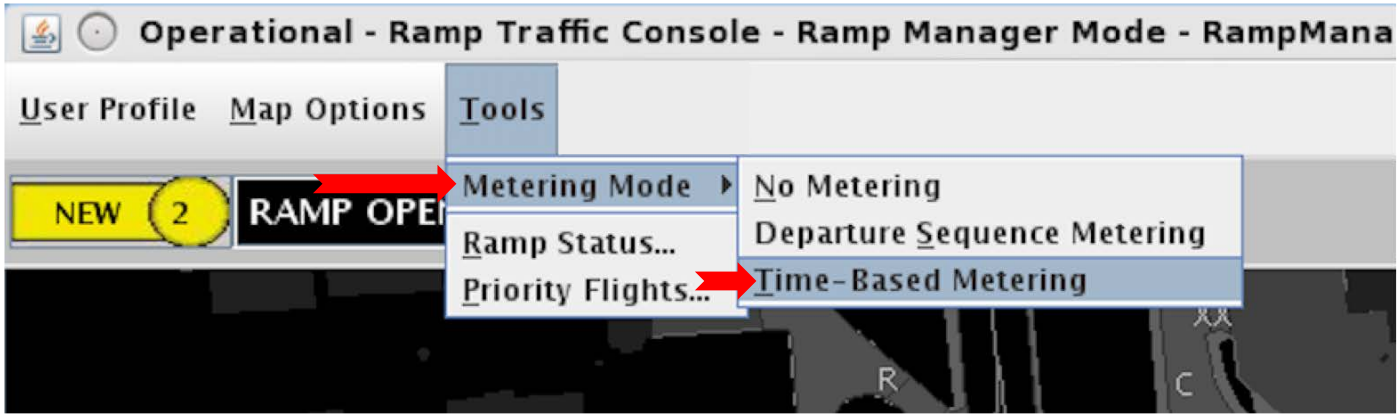
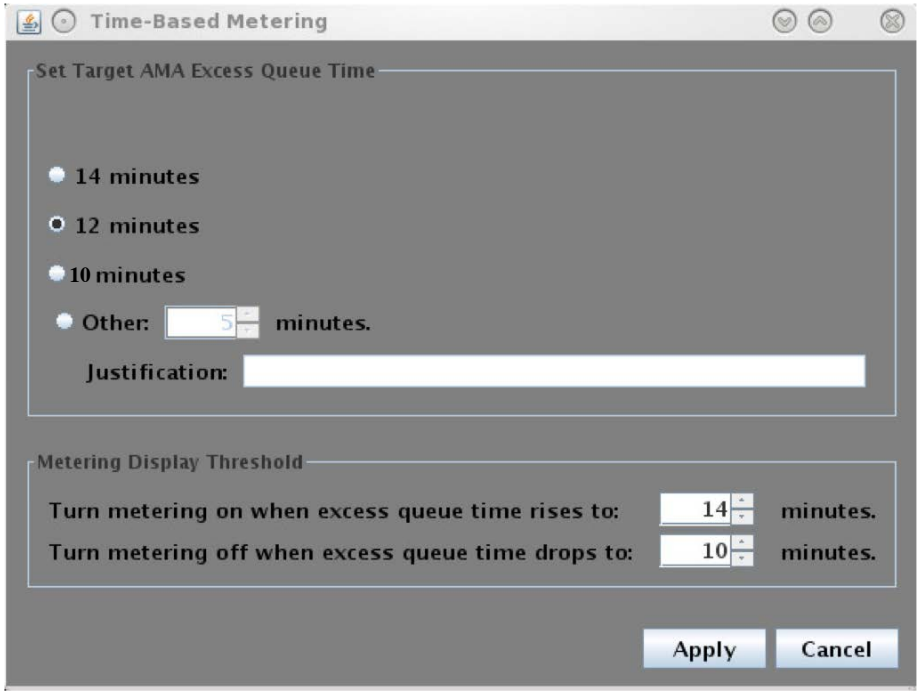


IADS Phase 1 Capabilities – Surface Metering

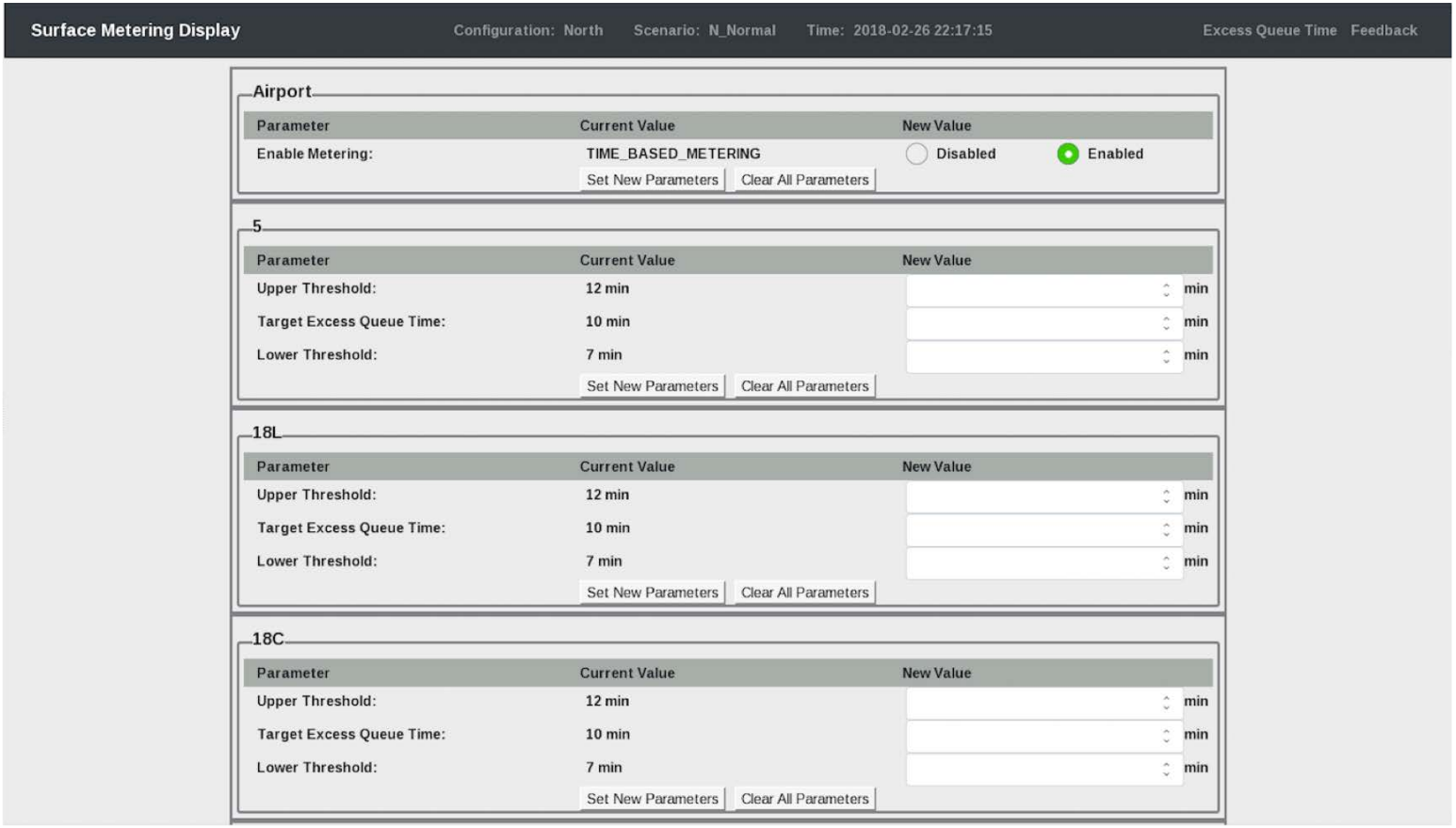


Initial Surface Metering Initiation

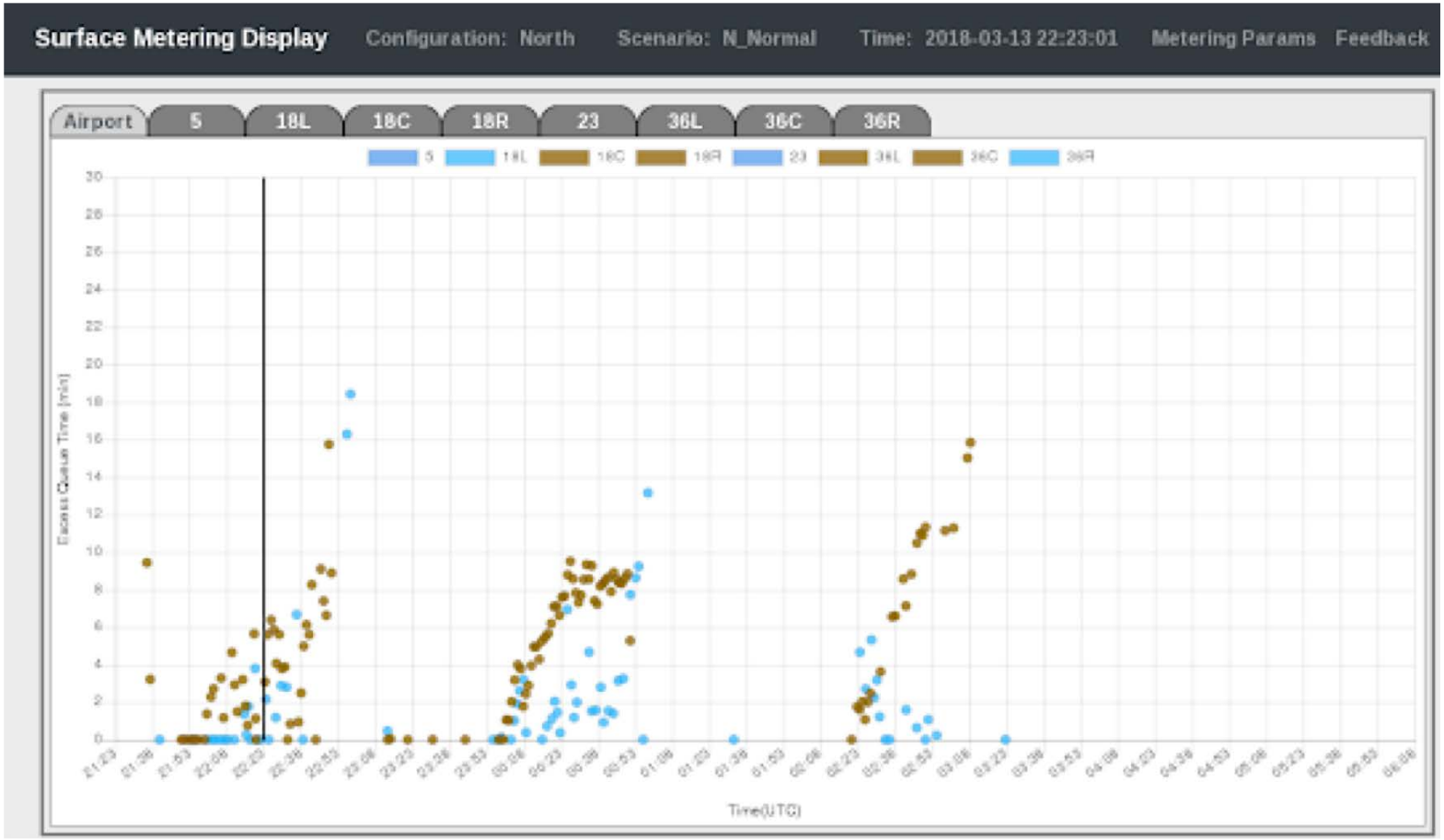




Evolution of Surface Metering Initiation



Evolution of Surface Metering Initiation – Excess Queue Time



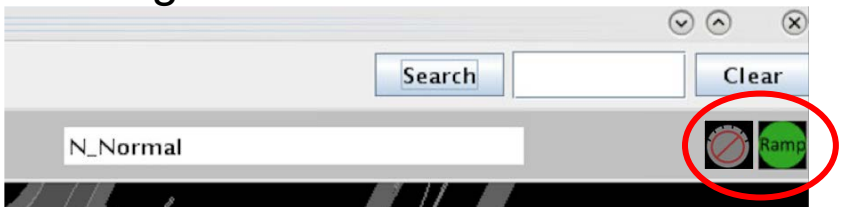
Evolution of Surface Metering Initiation – Excess Queue Time

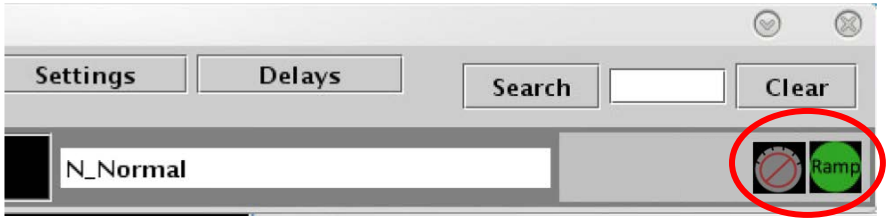
Metering by Runway Notification Across Interfaces

RTC

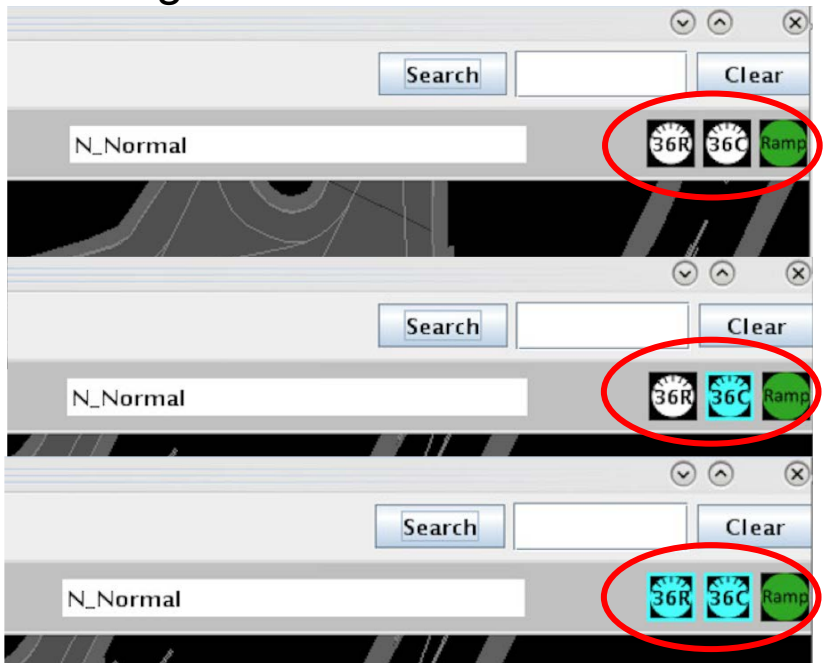
STBO

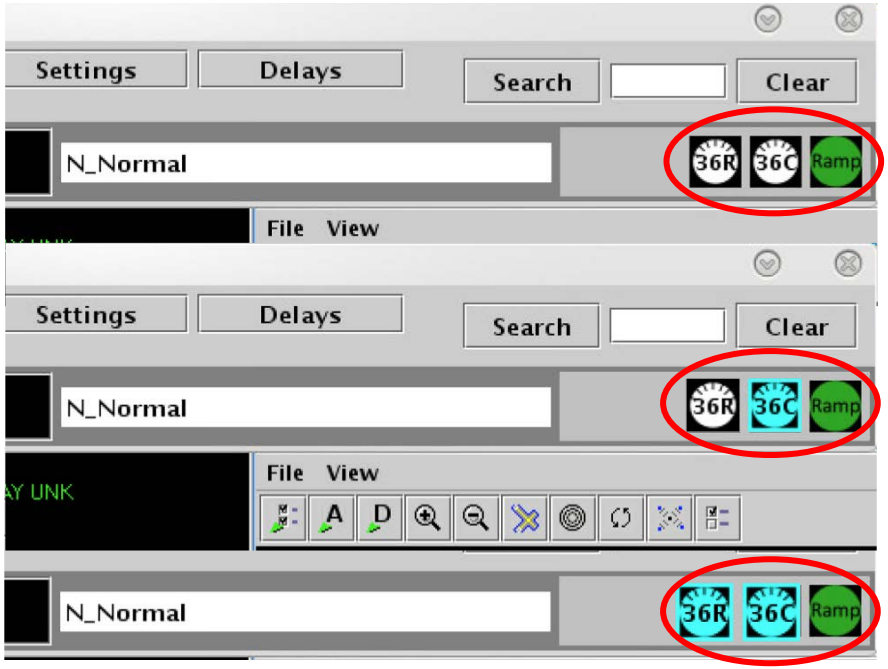
Metering not enabled icons:





Metering enabled icons:





Collaborative Surface Metering w/Ramp Tool Lessons

Lessons Learned from the Operational Field Evaluation

- Finalize the surface metering plan when accuracy is at its best. EOBTs predictive accuracy is currently at its best within 20 minutes prior to push/bank.
- For maximum benefit and flow performance, the ability to front load a bank is important to both departure and arrival flow performance. Otherwise, a ‘slow start’ may ripple through the bank
- In addition to EOBTs, actual flight pushback/taxi is useful to trigger metering. This gives substantially more control and leads to more consistent taxi out
- The ‘invisibility’ of EOBTs, metering guidance on ramp displays and communication of guidance to pilots and ground crews require a cultural adjustment
- Arrival configuration and changes in runway utilization are important for harmonious planning of surface metering with the arrival and departure banks
- High quality arrival times are important for departure surface metering (gate conflicts, use of shared runway resources)

Collaborative Surface Metering w/Ramp Tool Lessons

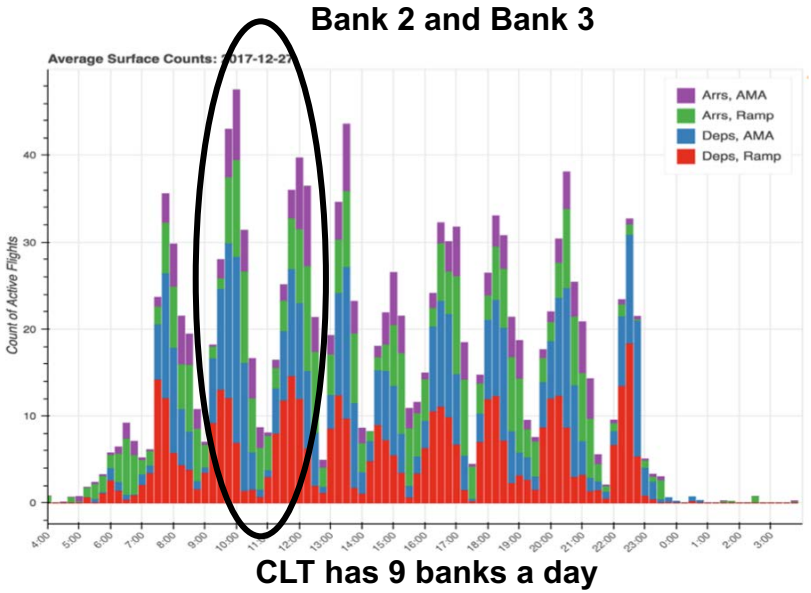
Lessons Learned from the Operational Field Evaluation

- **Finalize the surface metering plan when accuracy is at its best. EOBTs predictive accuracy is currently at its best within 20 minutes prior to push/bank.**
- **For maximum benefit and flow performance, the ability to front load a bank is important to both departure and arrival flow performance. Otherwise, a 'slow start' may ripple through the bank**
- **In addition to EOBTs, actual flight pushback/taxi is useful to trigger metering. This gives substantially more control and leads to more consistent taxi out**
- **The 'invisibility' of EOBTs, metering guidance on ramp displays and communication of guidance to pilots and ground crews require a cultural adjustment**
- Arrival configuration and changes in runway utilization are important for harmonious planning of surface metering with the arrival and departure banks
- High quality arrival times are important for departure surface metering (gate conflicts, use of shared runway resources)

Continuing Effort for Phase I

- Targeted at satisfying Surface and Data Sharing NIWG recommendations
  - "Evaluate the integration of departure metering that reflects the FAA's Surface CDM ConOps"
  - Reduce risk for TFDM deployment
  - Identify Operator needs to support and benefit from TFDM in an integrated environment
  - Identify likely benefits of Initial TBO using operational field demonstration results

- Moving forward
  - Surface metering expansion to other banks
  - Roll out more advanced features for deeper benefits
  - Expand electronic scheduling to ZTL
  - Share surface data elements via new SWIM feed
  - Continue to work with community on EOBT calibration



What is Next for ATD-2?

Phase 2 (Fusion, Sept 2018)

- Strategic planning tools (strategic/tactical fusion)
- Electronic Flight Data (EFD) Integration
- TFDM Terminal Publication (TTP) prototype
- Mobile app for EOBTs (GA community)
- ZTL/ATL airspace tactical scheduling
- Agile development from:
  - Field demo partner requests
  - TFDM risk reduction needs (as requested)
  - Surface CDM and CAT Team Input (as requested)

Phase 3 (Terminal, Sep 2019)

- Terminal departure airspace constraints
- Additional APREQ features
- Agile development from:
  - Field demo partner requests
  - TFDM risk reduction needs (as requested)
  - Surface CDM and CAT Team input (as requested)

Q&A

- Questions?

ATD-2
Integrated Arrival/Departure/Surface

NASA

Thank you!